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REPORT

OF THE

TESTS OF METALS

AND

OTHER MATERIALS

FOR

INDUSTRIAL PURPOSES

MADE WITH THE

UNITED STATES TESTING MACHINE AT WATERTOWN ARSENAL,
MASSACHUSETTS,

DURING

THE YEAR ENDED JUNE 30, 1884.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1886.

A. 1040

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

Report of "Tests of iron and steel and other materials for industrial purposes," by Maj. F. H. Parker, commanding the Watertown Arsenal.

DECEMBER 15, 1885.—Referred to the Committee on Printing.

WAR DEPARTMENT,
Washington City, December 3, 1884.

The Secretary of War has the honor to transmit to the United States Senate a letter of the Chief of Ordnance, United States Army, dated the 25th ultimo, and its accompanying report of "Tests of iron and steel and other materials for industrial purposes," made by Maj. F. H. Parker, Ordnance Department, United States Army, commanding the Watertown Arsenal, with the United States testing-machine during the fiscal year ended June 30, 1884.

Attention is respectfully invited to the remarks of the Chief of Ordnance touching the urgency of the need of an additional testing-machine, in order to provide increased facilities for the steady prosecution of such important work, an estimate for the additional machine having already been submitted by this Department, as shown on page 158 of the Book of Estimates.

ROBERT T. LINCOLN,
Secretary of War.

The PRESIDENT PRO TEMPORE UNITED STATES SENATE.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., November 25, 1884.

SIR: I have the honor to submit herewith, to be transmitted to Congress as required by law, the "Report of tests of iron and steel and other materials for industrial purposes," made by Maj. F. H. Parker, Ordnance Department, commanding the Watertown Arsenal, with the United States testing-machine during the fiscal year ending 30th June, 1884.

More than three-fourths of the tests made during the year were for the Government service, and unless an additional machine—estimated for—be provided to test the many small specimens submitted, all private work will soon have to be discontinued.

The machine was disabled during forty-one days, and this is an additional reason in favor of increased facilities for the steady prosecution of such important work.

Very respectfully, your obedient servant,

S. V. BENÉT,
Brigadier-General, Chief of Ordnance.

The Hon. SECRETARY OF WAR.

WATERTOWN ARSENAL,
Watertown, Mass., August 31, 1884.

SIR: I have the honor to report the results of public tests made on the Government testing-machine at this arsenal during the fiscal year ending June 30, 1884, in compliance with the act of Congress appropriating funds for that purpose.

As will be seen, these tests were made for industrial purposes and for the Government service, and their object was the determination of the strength of various kinds of material and different forms of construction.

The whole number of these public tests made during the year was 1,424.

In addition, 411 tests for private parties were made, making a total of 1,835 tests. A list of the names and residences of parties for whom private tests were made is appended.

The number of tests made during the year is less than that of the preceding year, owing to the different character of the tests, and because for a period of forty-one working days the machine was disabled and undergoing repairs. With that exception it has been in operation constantly, every work day finding Mr. J. E. Howard and his assistants in their places testing or preparing to test the various specimens presented; and although all available time during the year has been occupied, and all the testing work possible has been done, there has been generally an accumulation of private work on hand which had to wait, some of it for months, before an opportunity offered to comply with the urgent request of the parties and test their specimens. But public work necessarily took precedence, and much of it this year being for gun construction, consumed an unusual amount of time consequent upon the many measurements to be taken and the great care exercised. It is thought that what has been done in this direction is more reliable and satisfactory than what has heretofore resulted from tests of small specimens made on machines not readily manipulated. The desirability of testing larger and longer samples of gun material than the minute pieces which have heretofore been depended upon is recognized; it gives an opportunity for more accurate observation and determination of the physical qualities of the metal. This is exemplified to a limited extent by the larger bars of gun steel and cast iron given in this report. Some interesting points respecting the effects of the previous treatment of the steel is shown, which would not have been brought out by the usual small-sized specimens.

In the tangential tests an apparatus was devised to burst the hollow cylinders, which would give more accurate results than that heretofore used. The pistons did not enter the tested cylinder, but from a reservoir the fluid was forced through an aperture into the cylinder. Thus the surface of the latter pressed was unvarying. The usual mixture of wax and tallow was first tried, but was found not to flow and transmit the pressure properly. Finally glycerine was used for the cast iron and water for the steel cylinders with satisfactory effect.

The tests for industrial purposes consist principally of a series of latticed columns, a continuation of such tests made in previous years—tests of bricks and brick piers, of cement, concrete, and stone blocks, and of the holding power of nails and screws in woods, all of more or less interest and value to builders. A lack of time prevented a further prosecution of these or other miscellaneous tests, as well as a full analysis and summing up of the tests made.

As was the case in the previous year, nothing resulted from the programme of tests prepared by the American Society of Civil Engineers. No railroad companies, manufacturers, engineers, or other users of building material co-operated, as was requested, by sending members of structures or special shapes with the prescribed hand specimens, history of the metal and process of manufacture, diagrams, &c., which was for the purpose of obtaining and distributing valuable information on such subjects, and in which case the tests were free. Such a method was not followed in a single case. But members of structures and various specimens are continually received from railroad companies, manufacturers, and engineers for private tests, in which case payment of the actual expenses is made, and the report in private and confidential.

It was desired to make further tests upon riveted joints, in continuation of previous ones, and efforts were made to procure the proper specimens, fabricated from uniform metal of a fair quality, but makers declined to take the contract to supply what was wanted where great uniformity was required, and as it became evident that the amount of Government work would not admit of a prosecution of such tests the project was abandoned.

It is quite evident now that this one machine can, with great advantage, be occupied entirely in making tests for the different departments of the Government required in carrying on their current work. It is not improbable, indeed, that the ordnance service of the War Department alone will soon have sufficient testing work to fill the whole time of the machine, to the exclusion of work from all other sources; and as citizens, city governments, and corporations seem to have confidence in this testing-machine and its impartial and skillful management, the question arises whether or not it would not be advisable to supplement this with another smaller machine, as recommended in my last year's report, which would relieve this machine of much of its work.

During the year several new appliances and fixtures have been procured which add to the convenience and accuracy in making tests; also new and more delicate measuring instruments have been made here for use with the machine.

A more complete set of record books, properly printed blanks for reports, and for conducting the business of the testing department, have been obtained and a more methodical system established.

The receipts and expenditures during the year were as follows:

Amount appropriated for testing-machine and testing work	$10,000 00
Received during the year for private tests	994 13
	10,994 13
Amount expended for services and labor	6,220 14
Amount expended for steam-power, tools, implements, repairs, and improvements	4,102 32
Amount expended for materials for testing	28 35
Balance covered into Treasury	643 32
	10,994 13

Very respectfully, your obedient servant,

F. H. PARKER,
Major Ord. Dept., U. S. A., Commanding.

The Chief of Ordnance U. S. Army,
Washington, D. C.

REPORT OF TESTS

ON THE

STRENGTH OF STRUCTURAL MATERIAL,

MADE AT THE

WATERTOWN ARSENAL, MASS.,

DURING THE

FISCAL YEAR ENDED JUNE 30, 1884.

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TESTS OF STRENGTH OF STRUCTURAL MATERIAL.

1.—COMPRESSION OF WROUGHT-IRON COLUMNS.

LATTICED, BOX AND SOLID WEB.

The following tests complete the series of seventy-four columns, of which number forty were tested and included in the Report of Tests made at Watertown Arsenal for the year 1883.

The styles of posts represented are those composed of—

Channel bars with solid webs.

Channel bars and plates.

Plates and angles.

Channel bars with latticed sides.

Channel bars latticed on one side and with continuous plate on one side.

Sixteen posts were tested with flat ends; 18 were tested with 3½″ pin ends.

The pins were placed in the center of gravity of cross-section, except two posts of set K, which had the pins in the center of gravity of the channel bars, giving an eccentric bearing to these columns on account of the continuous plate on one side of the channel bars.

The pins were used in a vertical position, unless otherwise stated in the details of the tests.

In the testing machine the posts occupied a horizontal position. They were counter-weighted at the middle. Cast-iron bolsters for pin seats were used between the ends of the columns and the flat compression platforms of the testing machine.

The sectional areas were obtained from the weights of the channel bars, angles, and plates, which were weighed before any holes were punched, calling the sectional area, in square inches, one-tenth the weight in pounds per yard of the iron.

Compressions and sets were measured within the gauged length by a screw micrometer.

The gauged length covered the middle portion of the post, and was taken along the center line of the upper channel bar or plate, always using a length shorter than the distance between the eye-plates to obtain gaugings unaffected by the concentration of load at those points.

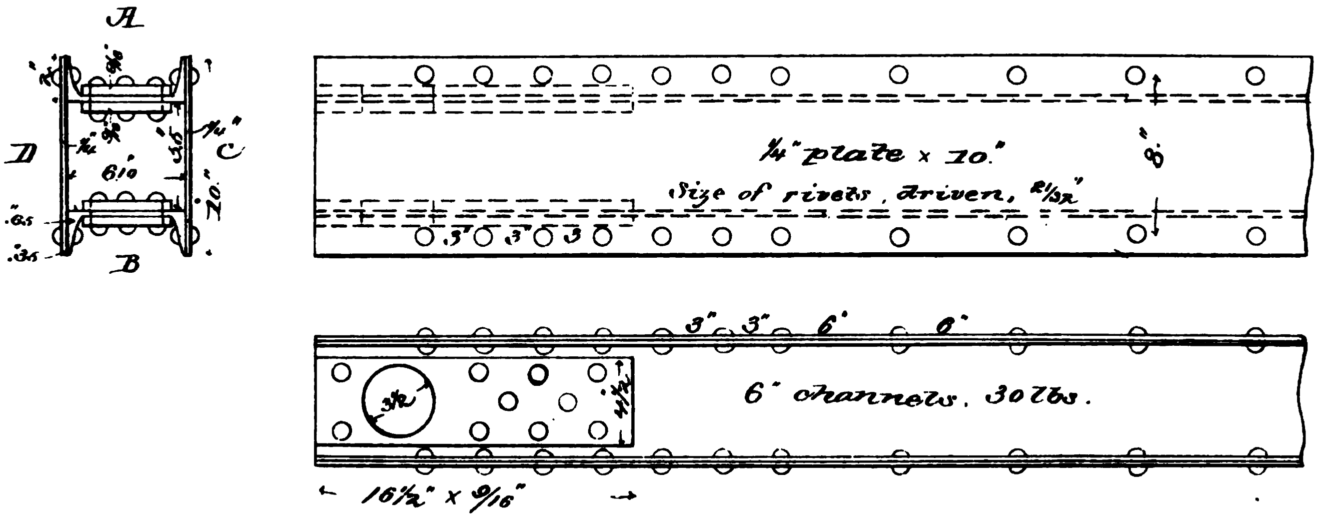
The deflections were measured at the middle of the post. An arm carrying a pointer was clamped to the post. The pointer, moving over the face of a dial, indicated the amount and direction of deflection.

Loads were gradually applied, measuring the compressions and deflections after each increment, returning at intervals to the initial load to determine the sets.

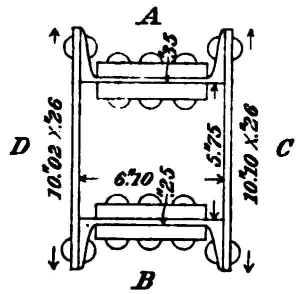
The maximum load the column was capable of sustaining was recorde as the ultimate strength, although previous to reaching this load considerable distortion may have been produced.

Set B

General dimensions.



No. 377.—SET B.



(Tested with flat ends.)

Total length, 10′ 7″.90.
Gauged length (along center line channel A), 80″.
Total weight (includes eye-plates), 538 pounds.

Sectional area.

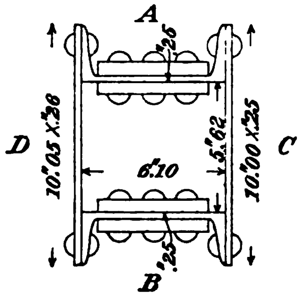
	Square inches.
Channel A, 10′ 8″; weight, 136 pounds; web, ″.35	3.83
Channel B, 10′ 8″; weight, 109 pounds; web, ″.25	3.07
Plate C, 10′ 8″; weight, 92 pounds	2.59
Plate D, 10′ 8″; weight, 92 pounds	2.59
	12.08

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0006	....	0.	0.	
20,000	....	.0026	....	0.	0.	
30,000	....	.0048	....	0.	0.	
40,000	....	.0068	....	0.	0.	
50,000	....	.0090	....	0.	0.	
5,000	....	....	—.0002	0.	0.	
60,000	....	.0116	....	—.01	0.	
70,000	....	.0140	....	—.01	0.	
80,000	....	.0162	....	—.01	0.	
90,000	....	.0182	....	—.02	0.	
100,000	....	.0209	....	—.02	0.	
5,000	....	....	—.0002	0.	0.	
110,000	....	.0231	....	—.02	0.	
120,000	....	.0254	....	—.03	0.	
130,000	....	.0279	....	—.03	0.	
140,000	....	.0302	....	—.03	0.	
150,000	....	.0324	....	—.03	0.	
5,000	....	....	—.0005	0.	0.	
160,000	....	.0349	....	—.03	0.	
170,000	....	.0372	....	—.03	0.	
180,000	....	.0398	....	—.04	0.	
190,000	....	.0421	....	—.04	0.	
200,000	....	.0445	....	—.04	0.	
5,000	....	....	—.0003	0.	0.	
210,000	....	.0465	....	—.04	0.	
220,000	....	.0490	....	—.04	0.	
230,000	....	.0516	....	—.01	0.	
240,000	....	.1540	....	—.05	0.	
250,000	....	.0564	....	—.06	0.	
5,000	....	....	—.0001	—.01	—.01	
260,000	....	.0589	....	—.06	—.01	
270,000	....	.0616	....	—.06	—.01	
280,000	....	.0640	....	—.06	—.01	
290,000	....	.0670	....	—.06	—.01	
300,000	....	.0699	....	—.06	—.01	
5,000	....	....	.0010	—.01	—.01	
310,000	....	.0729	....	—.06	—.01	

Applied loads.		In general length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
320,000	....	.0759	....	—.07	—.01	
330,000	....	.0789	....	—.07	—.01	
340,000	....	.0820	....	—.07	—.01	
350,000	....	.0858	....	—.08	—.01	
5,000	....	....	.0042	—.02	—.01	
360,000	....	.0898	....	—.08	—.01	
370,000	....	.0938	....	—.09	—.01	
380,000	....	.0993	....	—.10	—.01	
383,200	31.722	....	....	—.12	—.01	Ultimate strength.

Failed by buckling plate D between the riveting, at points 12″ from the middle, and 20″ from the end of the column.

No. 378.—Set B.



(Tested with flat ends.)

Total length, 10′ 7″.90.
Gauged length (along center line channel A), 80″.
Total weight (includes eye-plates), 515 pounds.

Sectional area.

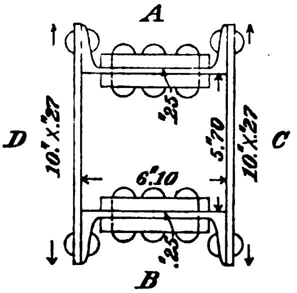
	Square inches.
Channel A, 10′ 8″; weight, 111 pounds; web, ″.25	3.12
Channel B, 10′ 8″; weight, 114 pounds; web, ″.25	3.21
Plate C, 10′ 8″; weight, 78 pounds	2.19
Plate D, 10′ 8″; weight, 92 pounds	2.59
	11.11

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0010	....	0.	0.	
20,000	....	.0034	....	0.	0.	
30,000	....	.0060	....	0.	0.	
40,000	....	.0084	....	0.	0.	
50,000	....	.0110	....	0.	0.	
5,000	....	....	—.0001	0.	0.	
60,000	....	.0134	....	0.	0.	
70,000	....	.0160	....	0.	0.	
80,000	....	.0187	....	0.	0.	
90,000	....	.0211	....	0.	0.	
100,000	....	.0234	....	0.	0.	
5,000	....	....	—.0001	0.	0.	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
110, 000	....	.0260	....	0.	0.	
120, 000	....	.0287	....	0.	0.	
130, 000	....	.0311	....	0.	0.	
140, 000	....	.0339	....	0.	0.	
150, 000	....	.0362	....	0.	0.	
5, 000	....	....	—.0001	0.	0.	
160, 000	....	.0390	....	0.	0.	
170, 000	....	.0416	....	0.	0.	
180, 000	....	.0442	....	0.	0.	
190, 000	....	.0470	....	0.	0.	
200, 000	....	.0495	....	0.	0.	
5, 000	....	....	+.0001	0.	0.	
210, 000	....	.0521	....	0.	0.	
220, 000	....	.0547	....	—.01	0.	
230, 000	....	.0572	....	—.01	0.	
240, 000	....	.0600	....	—.01	0.	
250, 000	....	.0629	....	—.01	0.	
5, 000	....	....	.0009	0.	0.	
260, 000	....	.0658	....	—.01	0.	
270, 000	....	.0688	....	—.01	0.	
280, 000	....	.0718	....	—.01	0.	
290, 000	....	.0747	....	—.01	0.	
300, 000	....	.0780	....	—.01	0.	
5, 000	....	....	.0033	0.	0.	
310, 000	....	.0814	....	—.01	0.	
320, 000	....	.0850	....	—.01	0.	
330, 000	....	.0890	....	—.01	0.	
340, 000	....	.0938	....	—.01	0.	
350, 000	....	.0998	....	—.01	0.	
5, 000	....	....	.0119	0.	—.08	
360, 000	....	.1050	....	—.04	—.08	
370, 000	....	.1173	....	—.04	—.08	
372, 900	33, 564	....	....	—.04	—.08	Ultimate strength.

Failed by buckling plate C 30″ from end and plate D 48″ from end of column.

No. 367.—Set B.



(Tested with 3½″ pins.)

Length, center to center of pins, 150″.
Gauged length, 150″.
Total weight, 722 pounds.
Counter-weight at middle, 360 pounds.

Sectional area.

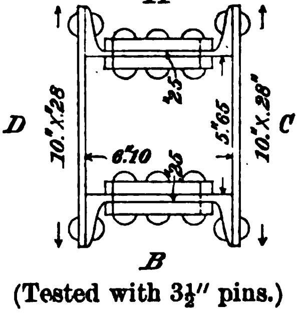
	Square inches.
Channel A, 15′ 8″; weight, 156 pounds; web, ″.25	2.99
Channel B, 15′ 8″; weight, 158 pounds; web, ″.25	3.03
Plate C, 15′ 8″; weight, 141 pounds; thickness, ″.27	2.70
Plate D, 15′ 8″; weight, 141 pounds; thickness, ″.27	2.70
	11.42

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5, 000		0.	0.	0.	0.	Initial load.
10, 000		.0020		0.	0.	
20, 000		.0053		0.	.01	
30, 000		.0093		0.	.01	
40, 000		.0137		0.	.02	
50, 000		.0180		0.	.02	
5, 000			.0003	.01	0.	
60, 000		.0229		.01	.04	
70, 000		.0271		.02	.05	
80, 000		.0317		.02	.05	
90, 000		.0363		.02	.05	
100, 000		.0409		.02	.05	
5, 000			.0003	.02	.02	
110, 000		.0457		.01	.05	
120, 000		.0503		.01	.06	
130, 000		.0549		0.	.06	
140, 000		.0597		0.	.06	
150, 000		.0644		0.	.06	
5, 000			.0007	.02	.02	
160, 000		.0691		0.	.06	
170, 000		.0738		0.	.06	
180, 000		.0787		0.	.06	
190, 000		.0834		0.	.06	
200, 000		.0886		0.	.06	
5, 000			.0009	0.	.02	
210, 000		.0938		0.	.06	
220, 000		.0998		—.01	.06	
230, 000		.1037		—.01	.06	
240, 000		.1089		—.01	.06	
250, 000		.1142		—.01	.06	
5, 000			.0021	+.02	.09	
260, 000		.1197		—.01	.06	
270, 000		.1248		—.01	.06	
280, 000		.1308		—.01	.06	
290, 000		.1365		—.01	.06	
300, 000		.1428		—.01	.06	
5, 000			.0052	+.02	.03	
310, 000		.1484		0.	.06	
320, 000		.1547		0.	.06	
330, 000		.1618		+.01	.06	
340, 000		.1699		.01	.06	
350, 000		.1794		.03	.06	
5, 000			.0169	.04	.03	
355, 000		.1866		.05	.05	
360, 000		.1930		.07	.03	
365, 000				.11	0.	Snapping sounds.
367, 000				.15	—.02	
369, 200	32, 329			.23	—.02	Ultimate strength.

Failed by horizontal deflection, perpendicular to the axis of the pins; with plate C on the concave side.

Pin-holes in channel-bar webs elongated ″.06.

No. 368.—Set B.



(Tested with 3½″ pins.)

Length, center to center of pins, 15′ 0″.1
Gauged length, 150″.
Total weight, 715 pounds.
Counter-weight at middle, 357 pounds.

Sectional area.

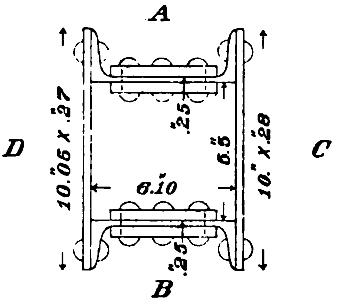
	Square inches.
Channel A, 15′ 8″; weight, 158 pounds; web, ″.25	3.03
Channel B, 15′ 8″; weight, 158 pounds; web, ″.25	3.03
Plate C, 15′ 8″; weight, 140 pounds; thickness, ″.28	2.68
Plate D, 15′ 8″; weight, 140 pounds; thickness, ″.28	2.68
	11.42

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0030	....	0.	—.01	
20,000	....	.0034	....	0.	—.02	
30,000	....	.0136	....	0.	—.03	
40,000	....	.0184	....	0.	—.03	
50,000	....	.0234	....	0.	—.03	
5,000	....	....	—.0001	0.	—.02	
60,000	....	.0284	....	0.	—.04	
70,000	....	.0333	....	0.	—.04	
80,000	....	.0383	....	0.	—.04	
90,000	....	.0433	....	0.	—.04	
100,000	....	.0481	....	0.	—.04	
5,000	....	....	—.0001	0.	—.03	
110,000	....	.0532	....	0.	—.04	
120,000	....	.0581	....	0.	—.04	
130,000	....	.0631	....	0.	—.05	
140,000	....	.0681	....	0.	—.05	
150,000	....	.0731	....	0.	—.05	
5,000	....	....	.0004	0.	—.04	
160,000	....	.0780	....	0.	—.05	
170,000	....	.0829	....	0.	—.05	
180,000	....	.0879	....	0.	—.06	
190,000	....	.0929	....	0.	—.06	
200,000	....	.0979	....	0.	—.06	
5,000	....	....	.0011	0.	—.04	
210,000	....	.1023	....	0.	—.06	
220,000	....	.1073	....	0.	—.07	
230,000	....	.1123	....	.01	—.07	
240,000	....	.1173	....	.01	—.07	
250,000	....	.1220	....	.02	—.07	
5,000	....	....	.0029	0.	—.05	
260,000	....	.1270	....	.02	—.07	
270,000	....	.1320	....	.02	—.07	
280,000	....	.1370	....	.02	—.07	
290,000	....	.1443	....	.02	—.08	
300,000	....	.1497	....	.02	—.08	
5,000	....	....	.0073	0.	—.07	
310,000	....	.1560	....	.03	—.10	
320,000	....	.1620	....	.04	—.10	
330,000	....	.1689	....	.04	—.10	
340,000	....	.1769	....	.05	—.12	
350,000	....	.1850	....	.05	—.13	
5,000	....	....	.0187	0.	—.11	
355,000	....	.1908	....	.05	—.13	
360,000	....	.1964	....	.05	—.13	
365,000	....	....	....	.05	—.15	
370,000	....	....	....	.07	—.17	
375,000	....	....	....	.12	—.20	
379,200	33,205	....	....	.15 .30	—.20	Ultimate strength.

Failed by horizontal deflection, perpendicular to the plane of the pins with plate C on the concave side.

Pin-holes in channel-bar webs elongated ″.05.

No. 356.—Set B.



(Tested with 3½" pins.)

Length, center to center of pins, 20'.
Total weight, 914 pounds.
Counter-weight at middle, 457 pounds.

Sectional area.

	Square inches.
Channel A, 20' 8"; weight, 210 pounds; web, ".25	3.05
Channel B, 20' 8"; weight, 209 pounds; web, ".25	3.03
Side-plate C, 20' 8"; weight, 188 pounds	2.73
Side-plate D, 20' 8"; weight, 180 pounds	2.61
	11.42

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inches.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0016	....	0.	0.	
20,000	....	.0061	....	0.	0.	
30,000	....	.0116	....	0.	.02	
40,000	....	.0169	....	0.	.03	
50,000	....	.0228	....	0.	.03	
5,000	....	....	—.0010	0.	.02	
60,000	....	.0282	....	—.01	.05	
70,000	....	.0342	....	—.01	.06	
80,000	....	.0400	....	—.01	.06	
90,000	....	.0461	....	—.01	.06	
100,000	....	.0510	....	—.01	.06	
5,000	....	....	—.0016	0.	.02	
110,000	....	.0576	....	—.02	.07	
120,000	....	.0638	....	—.02	.08	
130,000	....	.0699	....	—.02	.08	
140,000	....	.0759	....	—.02	.08	
150,000	....	.0820	....	—.02	.08	
5,000	....	....	—.0023	0.	.01	
160,000	....	0881	....	—.02	.09	
170,000	....	.0948	....	—.02	.09	
180,000	....	.1010	....	—.03	.10	
190,000	....	.1073	....	—.04	.10	
200,000	....	.1138	....	—.04	.10	
5,000	....	....	—.0023	0.	.01	
210,000	....	.1200	....	—.04	.10	
220.000	....	.1267	....	—.05	.10	
230,000	....	.1332	....	—.06	.10	
240,000	....	.1400	....	—.06	.11	
250,000	....	.1468	....	—.06	.10	
5,000	....	....	—.0011	0.	.03	
260,000	....	.1530	....	—.07	.13	
270,000	....	.1600	....	—.07	.14	
280,000	....	.1676	....	—.08	.14	
290,000	....	.1748	....	—.07	.14	
300,000	....	.1828	....	—.09	.15	

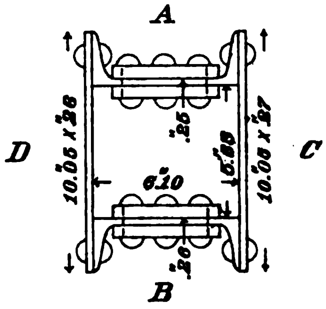
Applied loads.		In gauged lengths.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inches.*	*Inch.*	
5,000	....	....	.0039	—.02	.07	Micrometer removed.
310,000	....	....	....	—.18	.16	
315,000	....	....	....	—.13	.20	
320,000	....	....	....	—.15	.20	
327,000	....	....	....	—.19	.23	
330,000	....	....	....	—.21	.23	
335,000	....	....	....	—.24	.25	
340,000	....	....	....	—.30	.27	
342,000	29,947	....	....	—.45	.30	Ultimate strength.
310,000	....	....	....	—1.00	....	Sudden springing under this load and deflection.
155,000	....	....	....	—3.27	....	Load and deflection after springing.
5,000	....	....	....	—2.10	....	
160,000	....	....	....	—3.55	....	Maximum load sustained after above deflection.

Failed by horizontal deflection, perpendicular to the plane of the pins, plate C being on the convex side.

When sudden springing occurred, plate D was buckled between the riveting 24″ from the middle of the length of the column.

Pin-holes in channel-webs elongated ″.01½ each.

No. 357.—SET B.



(Tested with 3½″ pins.)

Length, center to center of pins, 20′.
Gauged length (along center line of channel A), 200″.
Total weight, 905 pounds.
Counter-weight at middle, 452 pounds.

Sectional area.

	Square inches.
Channel A, 20′ 8″; weight, 207 pounds; web, ″.25	3.00
Channel B, 20′ 8″; weight, 210 pounds; web, ″.26	3.05
Side plate C, 20′ 8″; weight, 183 pounds	2.66
Side plate D, 20′ 8″; weight, 179 pounds	2.60
	11.31

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	
10,000	....	.0039	....	0	0.	
20,000	....	.0104	....	0.	0.	
30,000	....	.0169	....	0.	0.	
40,000	....	.0228	....	0.	—.01	
50,000	....	.0293	....	—.01	—.01	
5,000	....	....	0.	0.	0.	
60,000	....	.0385	....	—.01	—.01	
70,000	....	.0416	....	—.01	—.01	
80,000	....	.0482	....	—.01	—.01	
90,000	....	.0547	....	—.01	—.01	
100,000	....	.0610	....	—.02	—.01	
5,000	....	....	0.	0.	0.	
110,000	....	.0675	....	—.02	—.01	
120,000	....	.0737	....	—.02	—.01	
130,000	....	.0804	....	—.03	—.02	
140,000	....	.0867	....	—.03	—.02	
150,000	....	.0931	....	—.03	—.02	
5,000	....	....	.0010	0.	—.01	
160,000	....	.0990	....	—.04	—.03	
170,000	....	.1055	....	—.04	—.03	
180,000	....	.1118	....	—.04	—.03	
190,000	....	.1186	....	—.04	—.03	
200,000	....	.1247	....	—.04	—.03	
5,000	....	....	.0016	0.	—.02	
210,000	....	.1312	....	—.05	—.03	
220,000	....	.1378	....	—.05	—.03	
230,000	....	.1444	....	—.06	—.03	
240,000	....	.1511	....	—.07	—.03	
250,000	....	.1580	....	—.07	—.03	
5,000	....	....	.0041	0.	—.03	
260,000	....	.1651	....	—.09	—.03	
270,000	....	.1725	....	—.10	—.03	
280,000	....	.1797	....	—.12	—.03	
290,000	....	.1870	....	—.13	—.03	
300,000	....	.1954	....	—.17	—.03	
5,000	....	....	.0110	—.08	—.03	Micrometer removed.
310,000	....	....	....	—.20	—.03	
315,000	....	....	....	—.22	—.03	
320,000	....	....	....	—.27	—.03	
325,000	....	....	....	—.32	—.03	
330,000	....	....	....	—.45	—.03	
330,100	29,186	....	....	—.48	—.03	Ultimate strength.

Failed by horizontal deflection; with plate C on the convex side.

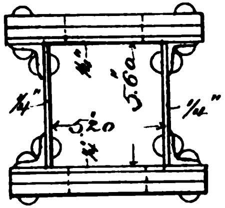
After reaching the maximum load, deflection increased slowly till it had reached —0″.75, the load at the time being 320,000 pounds. From this point the rate of deflection accelerated till it reached —1″.80 under 310,000 pounds load, when sudden springing occurred, increasing the horizontal deflection to —3″.35, while the pressure fell to 155,000 pounds.

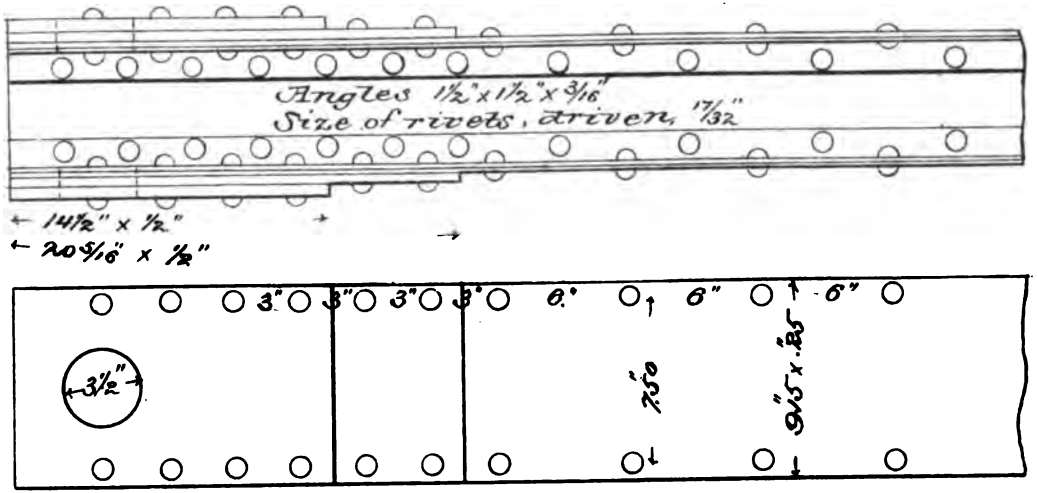
Released to the initial load the deflection was —2″.08.

A sharp bend was found 20 inches from the middle of the post; the plate on the concave side buckled between the riveting. Pin-holes elongated 0″.01.

Set C

General dimensions.





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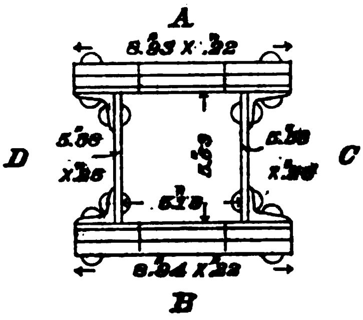
No. 371.—SET C.



(Tested with 3½″ pins.)

Length, center to center of pins, 9′ 11″.9.
Gauged length, 80″.
Total weight, 500 pounds.
Not counter-weighted.

Sectional area.

	Square inches.
Plate A, 10′ 8″; weight, 70 pounds	1.97
Plate B, 10′ 8″; weight, 70 pounds	1.97
Plate C, 10′ 8″; weight, 51 pounds	1.43
Plate D, 10′ 8″; weight, 50 pounds	1.41
Four angles, 10′ 8″; weight, 84 pounds	2.36
Total	9.14

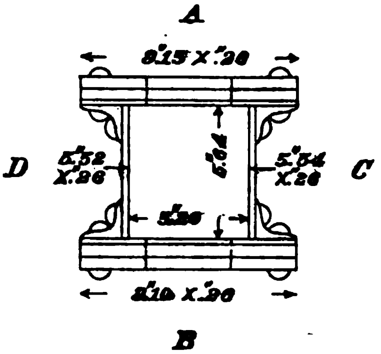
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0012	....	0.	0.	
20,000	....	.0048	....	0.	0.	
30,000	....	.0076	....	0.	0.	
40,000	....	.0108	....	0.	0.	
50,000	....	.0139	....	0.	.01	
5,000	....	....	0.	0.	0.	
60,000	....	.0172	....	0.	.01	
70,000	....	.0204	....	0.	.02	
80,000	....	.0234	....	0.	.02	
90,000	....	.0267	....	0.	.02	
100,000	....	.0300	....	0.	.02	
5,000	....	....	—.0001	0.	0.	
110,000	....	.0334	....	0.	.02	
120,000	....	.0369	....	0.	.02	
130,000	....	.0204	....	0.	.02	
140,000	....	.0440	....	0.	.02	
150,000	....	.0474	....	0.	.02	
5,000	....	....	.0011	0.	0.	
160,000	....	.0514	....	0.	.02	
170,000	....	.0549	....	0.	.02	
180,000	....	.0583	....	0.	.02	
190,000	....	.0623	....	0.	.02	
200,000	....	.0660	....	—.01	.02	
5,000	....	....	.0030	0.	0.	
210,000	....	.0700	....	—.01	.02	Snapping sounds.
220,000	....	.0740	....	—.01	.02	
230,000	....	.0782	....	—.01	.02	
240,000	....	.0824	....	—.01	.02	
250,000	....	.0870	....	—.01	.02	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5, 000	....	....	. 0072	+. 01	0.	
260, 000	....	. 0914	....	—. 01	. 03	
265, 000	....	. 0945	....	—. 01	. 03	
270, 000	....	. 0966	....	—. 01	. 04	
275, 000	....	. 0994	....	—. 01	. 05	
5, 000	....	....	. 0117	+. 02	. 03	
280, 000	....	....	....	0.	. 08	
285, 000	....	....	....	—. 01	. 10	
286, 100	31, 302	....	....	. 02	. 11	Ultimate strength.

Failed by buckling the plates 22″ from center of pin-hole, between the rivets in the first pitch beyond the eye-plates.

Pin-holes in continuous plates elongated ″.05.

No. 372.—Set C.



(Tested with 3½″ pins.)

Length, center to center of pins, 10′.
Gauged length, 80″.
Total weight, 525 pounds.
Not counter-weighted.

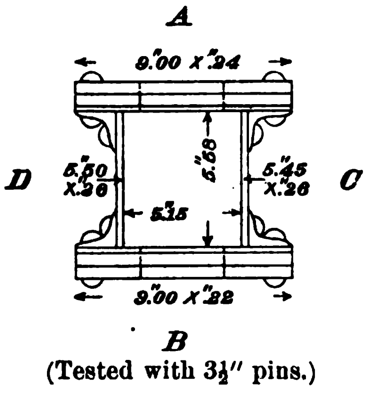
Sectional area.

	Square inches.
Plate A, 10′ 8″; weight, 81 pounds	2. 28
Plate B, 10′ 8″; weight, 81 pounds	2. 28
Plate C, 10′ 8″; weight, 59 pounds	1. 66
Plate D, 10′ 8″; weight, 52 pounds	1. 46
Four angles, 10′ 8″; weight, 85 pounds	2. 39
Total	10. 07

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5, 000	....	0.	0.	0.	0.	Initial load.
10, 000	....	.0013	....	0.	0.	
20, 000	....	.0043	....	0.	0.	
30, 000	....	.0073	....	0.	0.	
40, 000	....	.0103	....	0.	0.	
50, 000	....	.0134	....	0.	0.	
5, 000	....	....	—.0001	0.	0.	
60, 000	....	.0166	....	0.	0.	
70, 000	....	.0198	....	0.	0.	
80, 000	....	.0227	....	0.	0.	
90, 000	....	.0258	....	0.	0.	
100, 000	....	.0289	....	—.01	0.	
5, 000	....	....	0.	0.	0.	
110, 000	....	.0321	....	—.01	0.	
120, 000	....	.0353	....	—.01	—.01	
130, 000	....	.0382	....	—.01	—.01	
140, 000	....	.0418	....	—.01	—.01	
150, 000	....	.0449	....	—.01	—.01	
5, 000	....	....	.0009	0.	0.	
160, 000	....	.0480	....	—.01	—.02	
170, 000	....	.0512	....	—.01	—.02	
180, 000	....	.0544	....	—.01	—.02	
190, 000	....	.0578	....	—.01	—.02	
200, 000	....	.0612	....	—.01	—.02	
5, 000	....	....	.0023	0.	—.01	
210, 000	....	.0649	....	—.01	—.03	
220, 000	....	.0682	....	—.01	—.03	
230, 000	....	.0719	....	—.01	—.03	
240, 000	....	.0755	....	—.01	—.03	Snapping sounds.
250, 000	....	.0791	....	—.02	—.03	
5, 000	....	....	.0060	0.	—.02	
250, 000	....	.0812	....	—.02	—.03	
260, 000	....	.0832	....	—.02	—.03	
265, 000	....	.0858	....	—.02	—.03	
270, 000	....	.0878	....	—.02	—.03	
275, 000	....	.0899	....	—.02	—.03	
5, 000	....	....	.0089	0.	—.02	
280, 000	....	....	....	—.02	—.04	
285, 000	....	....	....	—.02	—.05	
290, 000	....	....	....	—.03	—.06	
295, 000	....	....	....	—.03	—.06	
300, 000	....	....	....	—.03	—.07	
305, 000	....	....	....	—.03	—.08	
310, 000	....	....	....	—.04	—.08	
315, 000	....	....	....	—.05	—.10	
319, 200	31, 698	....	....	—.04	—.17	Ultimate strength.

Failed by buckling the plates between the riveting. Plate A buckled 41″ from center of 3½″ pin; plate B buckled 20″ from center of 3½″ pin. Pin-holes in continuous plates elongated ″.07.

No. 370.—Set C.



(Tested with 3½″ pins.)

Length, center to center of pins, 15′—0″.
Gauged length, 100″.
Total weight, 668 pounds.
Counter-weight at middle, 334 pounds.

Sectional area.

	Square inches.
Plate A, 15′ 8″; weight, 106 pounds	2.03
Plate B, 15′ 8″; weight, 101 pounds	1.93
Plate C, 15′ 8″; weight, 72 pounds	1.38
Plate D, 15′ 8″; weight, 72 pounds	1.38
Four angles, 15′ 8″; weight, 130 pounds	2.49
Total	9.21

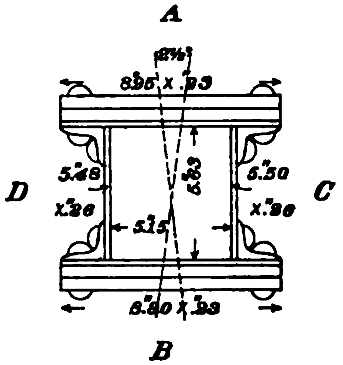
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000		0.	0.	0.	0.	Initial load.
10,000		.0009		0.	0.	
20,000		.0040		0.	0.	
30,000		.0076		0.	.02	
40,000		.0110		0.	.02	
50,000		.0147		0.	.03	
5,000			-.0004	0.	0.	
60,000		.0181		0.	.04	
70,000		.0219		0.	.04	
80,000		.0258		0.	.04	
90,000		.0292		0.	.04	
100,000		.0328		-.01	.05	
5,000			-.0011	0.	0.	
110,000		.0366		-.01	.05	
120,000		.0402		-.01	.05	
130,000		.0440		-.01	.05	
140,000		.0478		-.01	.06	
150,000		.0514		-.01	.06	
5,000			-.0019	0.	.01	
160,000		.0551		-.01	.06	
170,000		.0591		-.02	.06	
180,000		.0628		-.02	.06	
190,000		.0679		-.02	.06	
200,000		.0705		-.02	.06	
5,000			-.0022	0.	.02	
210,000		.0739		-.02	.07	
220,000		.0777		-.02	.08	
230,000		.0813		-.02	.09	
240,000		.0850		-.02	.10	
250,000		.0888		-.02	.10	
5,000			-.0016	+.02	.06	
250,000		.0882		-.02	.12	
255,000		.0899		-.02	.13	
260,000		.0918		-.02	.13	
270,000		.0956		-.02	.14	
275,000		.0972		-.01	.15	
5,000			-.0013	+.02	.07	
280,000				-.01	.17	
285,000				0.	.20	
290,000				+.01	.23	
291,500	31,650			.04	.30	Ultimate strength.

Failed by horizontal deflection, parallel to the axis of the pins.

Plate B buckled at the middle, between the rivets, when the deflection had reached ″.50 vertical.

Pin-holes in continuous plates elongated ″.04.

No. 369.—SET C.



(Tested with 3½″ pins.)

Pins not parallel. Angle between planes, 2¼°.
Length, center to center of pins, 15′—0″.
Gauged length, 100″.
Total weight, 680 pounds.
Counter-weight at middle, 334 pounds.

Sectional area.

	Square inches.
Plate A, 15′ 8″; weight, 115 pounds	2.20
Plate B, 15′ 8″; weight, 103 pounds	1.97
Plate C, 15′ 8″; weight, 75 pounds	1.44
Plate D, 15′ 8″; weight, 70 pounds	1.34
Four angles, each 15′ 8″; weight 32¼ pounds	2.49
	9.44

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0010	....	0.	0.	
20,000	....	.0032	....	0.	0.	
30,000	....	.0094	....	0.	.01	
40,000	....	.0136	....	0.	.01	
50,000	....	.0179	....	0.	.01	
5,000	....	....	.0003	0.	0.	
60,000	....	.0219	....	0.	.01	
70,000	....	.0259	....	—.01	.01	
80,000	....	.0299	....	—.01	.01	
90,000	....	.0339	....	—.02	.01	
100,000	....	.0379	....	—.02	.01	
5,000	....	....	.0009	0.	0.	
110,000	....	.0420	....	—.03	.01	
120,000	....	.0460	....	—.04	.01	
130,000	....	.0500	....	—.04	.01	
140,000	....	.0540	....	—.04	.01	
150,000	....	.0579	....	—.04	.01	
5,000	....	....	.0016	0.	.01	
160,000	....	.0618	....	.05	.02	
170,000	....	.0660	....	—.05	.03	
180,000	....	.0698	....	—.06	.03	Snapping sounds.
190,000	....	.0738	....	—.06	.04	
200,000	....	.0775	....	—.07	.04	
5,000	....	....	.0028	0.	.01	
210,000	....	.0814	....	—.07	.05	

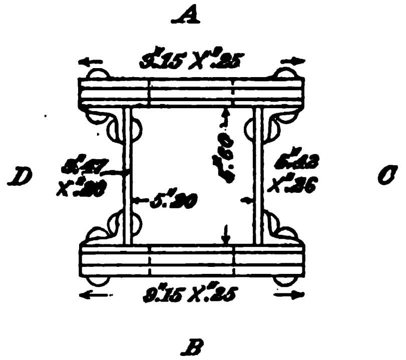
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
220,000	....	.0854	....	—.08	.05	
230,000	....	.0894	....	—.08	.06	
240,000	....	.0938	....	—.09	.06	
250,000	....	.0983	....	—.10	.07	
5,000	....	....	.0054	—.02	.02	
260,000	....	.1032	....	—.12	.10	
270,000	....	.1079	....	—.13	.12	
275,000	....	.1110	....	—.15	.12	
5,000	....	....	.0088	—.03	.03	
280,000	....	.1138	....	—.18	.12	
285,000	....	.1178	....	—.20	.12	
290,000	30,720	....	....	—.21	.03	Ultimate strength.

After passing the maximum load the pressure fell gradually to 285,000 pounds, while the middle deflections remained at —″.21 horizontal and ″.03 vertical.

The post then sprung suddenly perpendicular to the plane of the pins, increasing the middle deflections to —1″.10 horizontal and —″.30 vertical; plates A and B buckling between the rivets 24″ and 18″ from one end, giving the post a sharp bend at this point. The resistance of the post fell to 120,000 pounds.

Pin-holes in continuous plates elongated ″.04.

No. 354.—Set C.



(Tested with 3½″ pins.)

Length, center to center of pins, 20′—0″.
Gauged length (along center line of plate A), 200″.
Total weight, 830 pounds.
Counter-weight at middle, 415 pounds.

Sectional area.

	Square inches.
Plate A, 20′ 8″; weight, 142 pounds	2.06
Plate B, 20′ 8″; weight, 140 pounds	2.03
Plate C, 20′ 8″; weight, 97 pounds	1.41
Plate D, 20′ 8″; weight, 96 pounds	1.39
Four angles, each 20′ 8″; weight, 40¼ pounds	2.35
	9.24

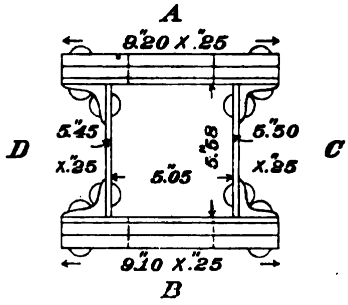
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0014	....	0.	0.	
15,000	....	.0043	....	0.	0.	
20,000	....	.0076	....	0.	0.	
25,000	....	.0114	....	0.	0.	
30,000	....	.0153	....	0.	0.	
40,000	....	.0229	....	0.	0.	
50,000	....	.0308	....	0.	0.	
5,000	....	....	—.0002	0.	—.02	
60,000	....	.0383	....	—.02	0.	
70,000	....	.0459	....	—.02	0.	
80,000	....	.0538	....	—.02	0.	
90,000	....	.0614	....	—.03	0.	
100,000	....	.0693	....	—.03	0.	
5,000	....	....	.0001	—.01	—.03	
110,000	....	.0773	....	—.05	0.	
120,000	....	.0858	....	—.05	0.	
130,000	....	.0931	....	—.05	0.	
140,000	....	.1011	....	—.06	0.	
150,000	....	.1091	....	—.06	0.	
5,000	....	....	.0010	—.01	—.03	
160,000	....	.1171	....	—.06	0.	
170,000	....	.1253	....	—.07	0.	
180,000	....	.1333	....	—.07	0.	
190,000	....	.1417	....	—.07	.01	
200,000	....	.1496	....	—.08	.02	
5,000	....	....	.0033	—.03	—.02	
210,000	....	.1581	....	—.10	.02	
220,000	....	.1663	....	—.11	.03	
230,000	....	.1744	....	—.12	.04	
236,000	....	....	....	....	....	Sharp, snapping sounds.
240,000	....	.1818	....	—.14	.08	
250,000	....	.1883	....	—.18	.15	
5,000	....	....	.0069	—.05	.03	Micrometer removed.
260,000	....	....	....	—.20	.27	
267,500	28,950	....	....	—.25	.40	Ultimate strength.

Failed by triple flexure; deflecting upwards at the middle, in the plane of the 3½″ pins. The maximum deflection occurred 2 feet from the middle of the length of the post.

Pin-holes A and B in the ¼″ plates elongated ″.02 to ″.03 each; the eye-plates slipping a corresponding amount along the axis of the post, and without elongating their pin-holes.

Frequent sharp, snapping sounds were heard, preceding the time of failure.

No. 355.—SET C.



(Tested with 3½″ pins.)

Length, center to center of pins, 20′.
Gauged length (along center line of plate A), 200″.
Total weight, 838 pounds.
Counter-weight at middle, 419 pounds.

Sectional area.

	Square inches.
Upper plate A, 20′ 8″; weight, 148 pounds	2.15
Under plate B, 20′ 8″; weight, 142 pounds	2.06
Side plate C, 20′ 8″; weight, 96 pounds	1.39
Side plate D, 20′ 8″; weight, 97 pounds	1.41
Four angles, each 20′ 8″; weight, 40¼ pounds	2.35
	9.36

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0083	....	0.	0.	
20,000	....	.0110	....	0.	0.	
30,000	....	.0190	....	—.01	0.	
40,000	....	.0266	....	—.01	0.	
50,000	....	.0343	....	—.02	0.	
5,000	....	....	.0010	0.	0.	
60,000	....	.0422	....	—.02	0.	
70,000	....	.0499	....	—.03	0.	
80,000	....	.0573	....	—.04	0.	
90,000	....	.0653	....	—.04	0.	
100,000	....	.0729	....	—.05	0.	
5,000	....	....	.0014	0.	0.	
110,000	....	.0808	....	—.06	0.	
120,000	....	.0880	....	—.06	0.	
130,000	....	.0956	....	—.06	0.	
140,000	....	.1036	....	—.06	0.	
150,000	....	.1108	....	—.07	0.	
5,000	....	....	.0019	0.	0.	
160,000	....	.1186	....	—.08	0.	
170,000	....	.1262	....	—.08	.02	
180,000	....	.1334	....	—.08	.02	
190,000	....	.1416	....	—.09	.03	
200,000	....	.1493	....	—.10	.04	
5,000	....	....	.0029	0.	0.	
210,000	....	.1570	....	—.10	.05	
220,000	....	.1650	....	—.11	.06	
230,000	....	.1730	....	—.13	.08	
240,000	....	.1810	....	—.14	.10	
250,000	....	.1881	....	—.17	.13	
5,000	....	....	.0057	—.04	.06	Micrometer removed.
260,000	....	....	....	—.20	....	
270,000	....	....	....	—.24	....	
279,700	29,879	....	....	—.36	....	Ultimate strength.

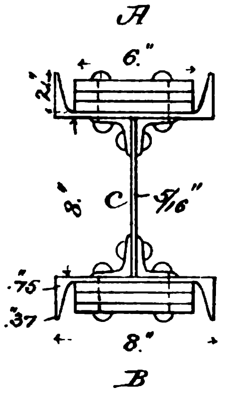
When the horizontal deflection had reached about ″.60, the column sprung suddenly, increasing the deflection to 2″.10; at the same time its resistance as a post fell to 70,000 pounds.

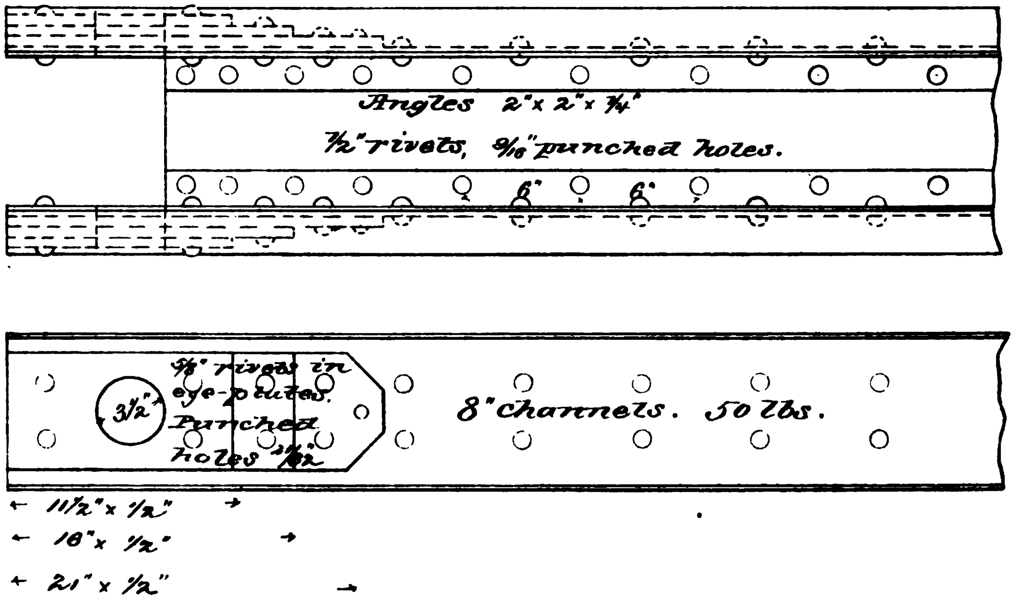
The bend at the middle was a sharp one, starting fractures where plates were exposed to tensile strain.

Pin-holes A and B in ¼″ plates elongated ″.03 each. Pin-holes in eye-plates not elongated. The plates slipped along the post in the line of pressure.

Set D

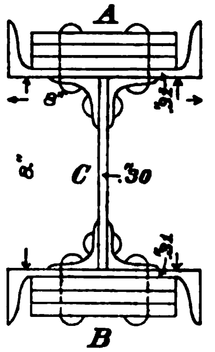
General dimensions





S Ex 35401

No. 360.—SET D.



(Tested with 3½" pins.)

Length, center to center of pins, 13' 4⅛".
Gauged length (along center line of channel A), 120".
Total weight, 865 pounds.
Counter-weight at middle, 432 pounds.

Sectional area.

	Square inches.
Channel A, 14' 4"; weight, 221 pounds; web, ".31	4.63
Channel B, 14' 4"; weight, 223 pounds; web, ".31	4.67
Web plate C, 13' 1"; weight, 103 pounds; thickness, ".30	2.36
Four angles, each 14' 4"; weight, 44 pounds	3.68
	15.34

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0004	....	0.	0.	
20,000	....	.0025	....	0.	0.	
30,000	....	.0050	....	0.	0.	
40,000	....	.0078	....	0.	.01	
50,000	....	.0100	....	0.	.02	
5,000	....	....	.0001	0.	0.	
60,000	....	.0129	....	0.	.01	
70,000	....	.0152	....	0.	.02	
80,060	....	.0176	....	0.	.02	
90,000	....	.0202	....	0.	.02	
100,000	....	.0229	....	0.	.02	
5,000	....	....	.0001	0.	0.	
110,000	....	.0253	....	0.	.02	
120,000	....	.0280	....	0.	.02	
130,000	....	.0306	....	0.	.02	
140,000	....	.0333	....	0.	.02	
150,000	....	.0360	....	0.	.02	
5,000	....	....	.0001	0.	0.	
160,000	....	.0390	....	—.01	.01	
170,000	....	.0417	....	—.01	.01	
180,000	....	.0444	....	—.02	.01	
190,000	....	.0471	....	—.03	.01	
200,000	....	.0501	....	—.03	.01	
5,000	....	....	.0004	0.	0.	
210,000	....	.0528	....	—.02	0.	
220,000	....	.0555	....	—.02	0.	
230,000	....	.0585	....	—.02	0.	
240,000	....	.0614	....	—.02	0.	
250,000	....	.0643	....	—.02	—.01	
5,000	....	....	.0010	0.	0.	
260,000	....	.0670	....	—.02	—.01	Snapping sounds.
270,000	....	.0703	....	—.02	—.01	
280,000	....	.0732	....	—.02	—.01	

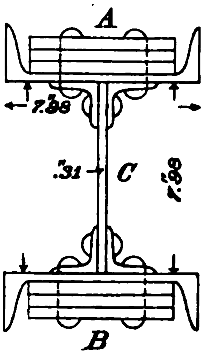
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
290,000	....	.0760	....	—.03	—.02	
300,000	....	.0790	....	—.03	—.02	
5,000	....	....	.0015	0.	0.	
310,000	....	.0820	....	—.03	-.02	
320,000	....	.0852	....	—.03	—.02	
330,000	....	.0882	....	—.03	—.02	
340,000	....	.0918	....	—.03	—.02	
350,000	....	.0950	....	—.03	—.02	
5,000	....	....	.0028	0.	+.04	
360,000	....	.0984	....	—.01	+.01	
370,000	....	.1020	....	—.01	.01	
380,000	....	.1052	....	—.01	.02	
390,000	....	.1092	....	—.01	.03	
400,000	....	.1129	....	0.	.05	
5,000	....	....	.0054	+.02	.11	
410,000	....	.1177	....	.02	.11	
420,000	....	.1223	....	.02	.12	
425,000	....	.1249	....	.02	.13	
430,000	....	.1272	....	.02	.15	
435,000	....	.1298	....	.02	.17	
440,000	....	....	....	.03	.20	
445,000	....	....	....	.04	.22	
450,000	....	....	....	.04	.24	
455,000	....	....	....	.05	.27	
460,000	....	....	....	.06	.33	
465,000	....	....	....	.07	.41	
465,700	....	....	....	.07	.47	
470,000	....	....	....	.08	.53 .65	
475,000	30,965	....	....	.06	.82	Ultimate strength.
470,000	....	....	....	0.	1.10	
460,000	....	....	....	—.05	1.22	
5,000	....	....	....	—.02	.94	

Failed by deflecting upward in the plane of the 3½″ pins.

When released from stress the post sprung diagonally, showing permanent deflections of about —″.20 horizontal, and +″.20 vertical.

Pin-holes in webs of the channels elongated ″.02; those in the eye-plates did not elongate, but slipped along the webs of the channel-bars.

No. 361.—Set D.



(Tested with 3½″ pins.)

Length, center to center of pins, 13′ 4″.
Gauged length (along center line of channel A), 120″.
Total weight, 890 pounds.
Counter-weight at middle, 445 pounds.

Sectional area.

	Square inches.
Channel A, 14′ 4″; weight, 240 pounds; web	5.02
Channel B, 14′ 4″; weight, 221 pounds; web	4.63
Web plate C, 13′ 1″; weight, 103 pounds; thickness, ″.31	2.36
Four angles, each 14′ 4″; weight, 43 pounds	3.39
Total	15.40

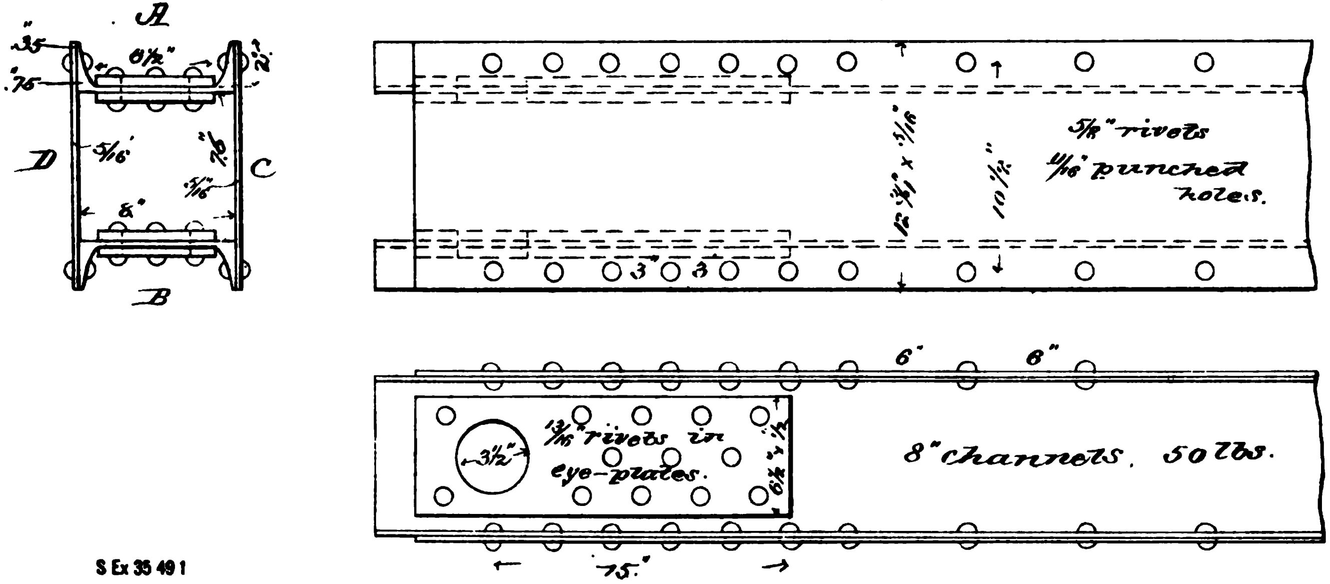
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0006	....	0.	0.	
20,000	....	.0029	....	0.	0.	
30,000	....	.0053	....	0.	0.	
40,000	....	.0077	....	—.01	0.	
50,000	....	.0101	....	—.01	0.	
5,000	....	....	0.	0.	0.	
60,000	....	.0124	....	—.01	0.	
70,000	....	.0149	....	—.01	0.	
80,000	....	.0172	....	—.01	0.	
90,000	....	.0197	....	—.01	0.	
100,000	....	.0220	....	—.02	0.	
5,000	....	....	—.0002	0.	0.	
110,000	....	.0244	....	—.02	0.	
120,000	....	.0270	....	—.02	0.	
130,000	....	.0297	....	—.02	0.	
140,000	....	.0324	....	—.02	0.	
150,000	....	.0350	....	—.02	0.	
5,000	....	....	—.0003	0.	0.	
160,000	....	.0379	....	—.03	0.	
170,000	....	.0406	....	—.03	0.	
180,000	....	.0432	....	—.03	0.	Snapping sounds.
190,000	....	.0459	....	—.03	0.	
200,000	....	.0486	....	—.03	0.	
5,000	....	....	—.0002	0.	—.01	
210,000	....	.0513	....	—.03	—.01	
220,000	....	.0539	....	—.03	—.01	
230,000	....	.0565	....	—.03	—.01	
240,000	....	.0592	....	—.03	—.01	
250,000	....	.0619	....	—.03	—.01	
5,000	....	....	0.	0.	—.01	
260,000	....	.0645	....	—.03	—.01	
270,000	....	.0673	....	—.04	—.01	
280,000	....	.0700	....	—.04	—.01	
290,000	....	.0727	....	—.04	—.01	
300,000	....	.0754	....	—.04	—.01	
5,000	....	....	.0005	0.	—.01	
310,000	....	.0783	....	—.04	—.01	
320,000	....	.0810	....	—.04	—.01	
330,000	....	.0838	....	—.05	—.01	
340,000	....	.0869	....	—.05	—.02	
350,000	....	.0898	....	—.05	—.02	
5,000	....	....	.0016	0.	—.02	
360,000	....	.0930	....	—.05	—.02	
370,000	....	.0959	....	—.06	—.02	
380,000	....	.0993	....	—.06	—.02	
390,000	....	.1024	....	—.06	—.02	
400,000	....	.1059	....	—.06	—.02	
5,000	....	....	.0040	0.	—.01	
410,000	....	.1104	....	—.07	—.01	
420,000	....	.1131	....	—.07	—.01	
430,000	....	.1168	....	—.07	—.01	
440,000	....	.1209	....	—.08	—.01	
450,000	....	.1250	....	—.09	—.01	
5,000	....	....	.0093	—.02	0.	
460,000	....	.1303	....	—.11	0.	
465,000	....	.1333	....	—.12	0.	
470,000	....	.1356	....	—.13	0.	
475,000	....	.1380	....	—.14	0.	
5,000	....	....	.0149	—.05	+.02	
480,000	....	....	....	—.23	.03	
485,000	31,494	....	....	—.29	.05	Ultimate strength.
422,000	....	....	....	—1.00	.08	
5,000	....	....	....	—.57	.08	

Failed by horizontal deflection, perpendicular to the plane of the 3½″ pins.

Pin-holes in channel-bar webs elongated ″.01½ each.

Set E

General dimensions



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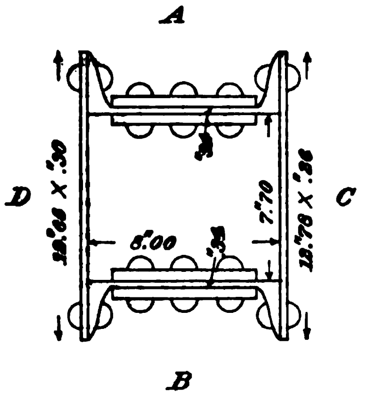
No. 379.—SET E.



(Tested with flat ends.)

Total length, 13′ 11″.80.
Gauged length (along center line channel A), 100″.
Total weight (includes eye-plates), 955 pounds.

Sectional area.

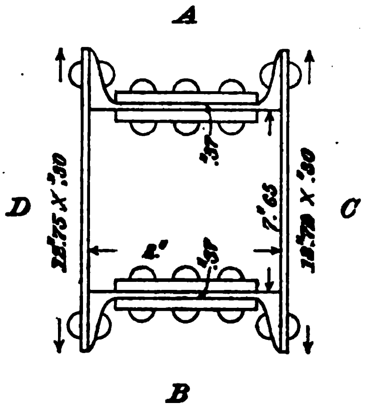
	Square inches.
Channel A, 14′ 4″; weight, 237 pounds; web, ″.34	4.96
Channel B, 14′ 4″; weight, 235 pounds; web, ″.34	4.91
Plate C, 14′; weight, 152 pounds	3.26
Plate D, 14′; weight, 181 pounds	3.88
Total	17.01

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000		0.	0.	0.	0.	Initial load.
20,000		.0012		0.	0.	
40,000		.0052		0.	0.	
60,000		.0092		0.	0.	
80,000		.0132		—.01	0.	
100,000		.0172		—.01	0.	
10,000			—.0001	0.	0.	
120,000		.0214		—.01	0.	
140,000		.0254		—.01	0.	
160,000		.0298		—.01	0.	
180,000		.0339		—.01	0.	
200,000		.0379		—.01	0.	
10,000			—.0002	0.	0.	
220,000		.0422		—.01	0.	
240,000		.0464		—.01	0.	
260,000		.0508		—.01	0.	
280,000		.0550		—.01	0.	
300,000		.0593		—.02	0.	
10,000			—.0001	0.	0.	
320,000		.0633		—.02	0.	
340,000		.0678		—.02	0.	
360,000		.0722		—.02	0.	
380,000		.0768		—.02	0.	
400,000		.0812		—.02	0.	
10,000			.0008	0.	0.	
420,000		.0859		—.02	0.	
440,000		.0906		—.03	0.	
460,000		.0959		—.03	0.	
480,000		.1012		—.03	0.	
500,000		.1069		—.03	0.	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10, 000	....	....	.0047	0.	0.	
510, 000	....	.1098	....	—. 03	0.	
520, 000	....	.1133	....	—. 03	0.	
530, 000	....	.1166	....	—. 03	0.	
540, 000	....	.1198	....	—. 04	0.	
550, 000	....	.1233	....	—. 04	0.	
560, 000	....	.1278	....	—. 05	0.	
570, 000	....	.1334	....	—. 05	0.	
580, 000	....	.1410	....	—. 05	0.	
590, 000	....	.1506	....	—. 06	0.	
594, 500	34, 950	....	....	....	....	Ultimate strength.

Failed by buckling between the riveting plate C at a distance of 4 feet from the south end, and plate D 2 feet from the south end of the column.

No. 380.—Set E.



(Tested with flat ends.)

Total length, 13′ 11″.80.
Gauged length (along center line channel A), 100″.
Total weight (includes eye-plates), 990 pounds.

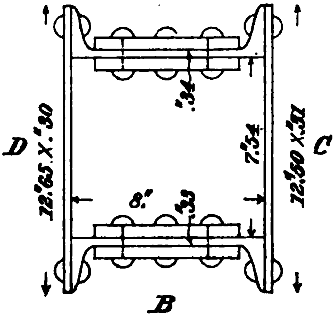
Sectional area.

	Square inches.
Channel A, 14′ 4″; weight, 245 pounds; web, ″.37	5.13
Channel B, 14′ 2″; weight, 241 pounds; web, ″.37	5.10
Plate C, 14′; weight, 177 pounds	3.80
Plate D, 14′; weight, 176 pounds	3.77
Total	17.80

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0012	....	0.	0.	
40,000	....	.0052	....	0.	0.	
60,000	....	.0090	....	0.	0.	
80,000	....	.0130	....	0.	0.	
100,000	....	.0170	....	—.01	0.	
10,000	....	....	—.0008	0.	0.	
120,000	....	.0210	....	—.01	+.01	
140,000	....	.0250	....	—.01	+.01	
160,000	....	.0292	....	—.01	+.01	
180,000	....	.0330	....	—.01	+.01	
200,000	....	.0372	....	—.01	+.01	
10,000	....	....	.0000	0.	0.	
220,000	....	.0412	....	—.02	+.01	
240,000	....	.0453	....	—.02	+.01	
260,000	....	.0496	....	—.02	+.01	
280,000	....	.0536	....	—.02	+.01	
300,000	....	.0578	....	—.02	+.01	
10,000	....	....	.0001	0.	0.	
320,000	....	.0620	....	—.03	+.01	
340,000	....	.0662	....	—.03	+.01	
360,000	....	.0705	....	—.03	+.01	
380,000	....	.0747	....	—.03	+.01	
400,000	....	.0790	....	—.04	+.01	
10,000	....	....	.0010	0.	0.	
420,000	....	.0833	....	—.04	+.01	
440,000	....	.0883	....	—.04	+.01	
460,000	....	.0929	....	—.04	+.01	
480,000	....	.0980	....	—.04	+.01	
500,000	....	.1032	....	—.05	+.01	
10,000	....	....	.0049	—.01	0.	
510,000	....	.1067	....	—.05	+.01	
520,000	....	.1100	....	—.06	+.01	
530,000	....	.1128	....	—.06	+.01	
540,000	....	.1160	....	—.06	+.01	
550,000	....	.1192	....	—.06	+.01	
560,000	....	.1228	....	—.07	+.01	
570,000	....	.1267	....	—.07	+.01	
580,000	....	.1310	....	—.07	+.01	
590,000	....	.1370	....	—.08.	—.01	
600,000	....	.1430	....	—.09	—.01	
10,000	....	....	.0231	—.04	—.01	
610,000	....	....	....	—.10	—.02	
620,000	....	....	....	—.12	—.05	
630,000	....	....	....	—.15	—.07	
633,600	35,596	....	....	....	....	Ultimate strength.

Failed by triple flexure, with plate C on the convex side at the middle.

No. 358.—SET E.



(Testèd with 3½″ pins.)

Length, center to center of pins, 20′—0″.
Gauged length (along center line of channel A), 200″.
Total weight, 1,395 pounds.
Counter-weight at middle, 697 pounds.

Sectional area.

	Square inches.
Channel A, 21′; weight, 347 pounds; web, ″.34	4.96
Channel B, 21′; weight, 347 pounds; web, ″.33	4.96
Side plate C, 20′ 8″; weight, 266 pounds	3.86
Side plate D, 20′ 8″; weight, 275 pounds	3.99
	17.77

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0030	....	0.	0.	
40,000	....	.0106	....	0.	0.	
60,000	....	.0186	....	—.01	—.01	
80,000	....	.0261	....	—.01	—.01	
100,000	....	.0344	....	—.01	—.01	
10,000	....	....	.0004	0.	—.01	
120,000	....	.0425	....	—.02	—.01	
140,000	....	.0507	....	—.02	—.01	
160,000	....	.0586	....	—.02	—.01	
180,000	....	.0667	....	—.02	—.01	
200,000	....	.0747	....	—.02	—.02	
10,000	....	....	.0008	0.	—.01	
220,000	....	.0829	....	—.01	—.02	
240,000	....	.0911	....	—.02	—.02	
260,000	....	.0993	....	—.02	—.02	
280,000	....	.1076	....	—.02	—.02	
300,000	....	.1161	....	—.02	—.02	
10,000	....	....	.0011	0.	—.02	
320,000	....	.1246	....	—.02	—.03	
340,000	....	.1330	....	—.02	—.04	
360,000	....	.1420	....	—.03	—.04	
380,000	....	.1508	....	—.03	—.04	
400,000	....	.1591	....	—.03	—.04	
10,000	....	....	.0034	—.01	—.04	
410,000	....	.1638	....	—.03	—.04	
420,000	....	.1684	....	—.03	—.04	
430,000	....	.1729	....	—.03	—.04	
440,000	....	.1775	....	—.03	—.05	
450,000	....	.1820	....	—.03	—.05	
10,000	....	....	.0056	—.01	—.06	
460,000	....	.1872	....	—.03	—.07	
470,000	....	.1920	....	—.03	—.08	
480,000	....	.1970	....	—.03	—.08	
490,000	....	.2020	....	—.03	—.09	
500,000	....	.2071	....	—.03	—.09	
10,000	....	....	.0099	—.01	—.09	Micrometer removed.
510,000	....	....	....	—.03	—.10	
520,000	....	....	....	—.03	—.10	
525,000	....	....	....	—.03	—.12	
530,000	....	....	....	—.03	—.12	
535,000	....	....	....	+.01	—.12	
540,000	....	....	....	.03	—.12	
545,000	....	....	....	.04	—.13	
550,000	....	....	....	.06	—.13	
555,000	....	....	....	.08	—.13	
560,000	....	....	....	.12	—.15	
565,000	....	....	....	.14	—.16	
568,000	....	....	....	.19	—.19	
570,000	32,077	....	....	.32	—.21	Ultimate strength.

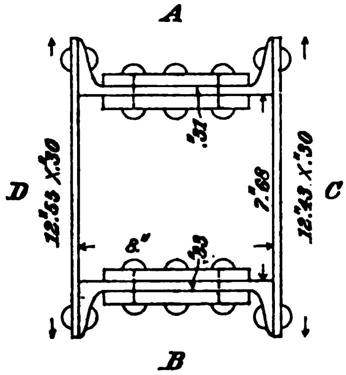
Failed by horizontal deflection, perpendicular to the plane of the pins; concave on the side of plate C.

Pin holes in channel-bar webs elongated .″06 each.

Pin holes in eye-plates elongated .″03 each.

The test was discontinued when the horizontal deflection had reached ″.55; which at the time was slowly increasing.

No. 359.—Set E.



(Tested with 3½" pins.)

Length, center to center of pins, 20′—0″.
Gauged length (along center line of channel A), 200″.
Total weight, 1,362 pounds.
Counter weight at middle, 681 pounds.

Sectional area.

	Square inches.
Channel A, 21′; weight, 322 pounds; web, ″.31	4.60
Channel B, 21′; weight, 345 pounds; web, ″.33	4.93
Side plate C, 20′ 8″; weight, 273 pounds	3.96
Side plate D, 20′ 8″; weight, 257 pounds	3.73
	17.22

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0036	....	0.	0.	
40,000	....	.0117	....	—.01	0.	
60,000	....	.0192	....	—.02	0.	
80,000	....	.0272	....	—.03	0.	
100,000	....	.0354	....	—.03	0.	
10,000	....	....	—.0001	0.	0.	
120,000	....	.0442	....	—.04	0.	
140,000	....	.0521	....	—.05	0.	
160,000	....	.0607	....	—.05	0.	
180,000	....	.0691	....	—.06	0.	
200,000	....	.0778	....	—.07	0.	
10,000	....	....	0.	0.	0.	
220,000	....	.0853	....	—.08	—.01	
240,000	....	.0940	....	—.08	—.01	
260,000	....	.1028	....	—.09	—.02	
280,000	....	.1116	....	—.10	—.02	
300,000	....	.1204	....	—.11	—.03	
10,000	....	....	.0005	—.01	—.02	
320,000	....	.1292	....	—.11	—.03	
340,000	....	.1381	....	—.12	—.03	
360,000	....	.1474	....	—.13	—.04	
380,000	....	.1570	....	—.14	—.04	
400,000	....	.1660	....	—.14	—.04	
10,000	....	....	.0034	—.02	—.03	
410,000	....	.1714	....	—.14	—.05	
420,000	....	.1761	....	—.15	—.06	
430,000	....	.1809	....	—.16	—.07	

Applied loads		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
440,000	....	.1857	....	—.17	—.07	
450,000	....	.1907	....	—.18	—.08	
10,000	....	....	.0051	—.03	—.05	
460,000	....	.1960	....	—.18	—.09	
470,000	....	.2011	....	—.18	—.09	
480,000	....	.2061	....	—.19	—.09	
490,000	....	.2118	....	—.20	—.10	
500,000	....	.2180	....	—.21	—.10	
10,000	....	....	.0094	—.06	—.06	Micrometer removed.
510,000	....	....	....	—.23	—.11	
520,000	....	....	....	—.25	—.12	
528,000	....	....	....	....	....	Snapping sounds.
530,000	....	....	....	—.31	—.13	
535,000	....	....	....	—.33	—.13	
540,000	....	....	....	—.37	—.16	
545,000	....	....	....	—.42	—.18	
550,000	....	....	....	—.51	—.20	
555,000	....	....	....	—.65	—.21	
555,400	32,253	....	....	—.74	—.22	Ultimate strength.
536,000	....	....	....	—1.00	—.24	

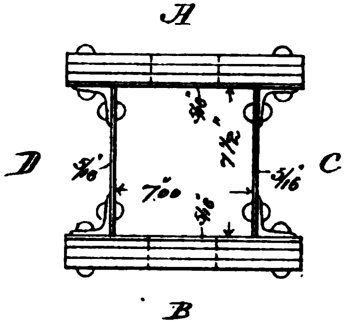
Failed by horizontal deflection, perpendicular to the plane of the pins; convex on the side of plate C.

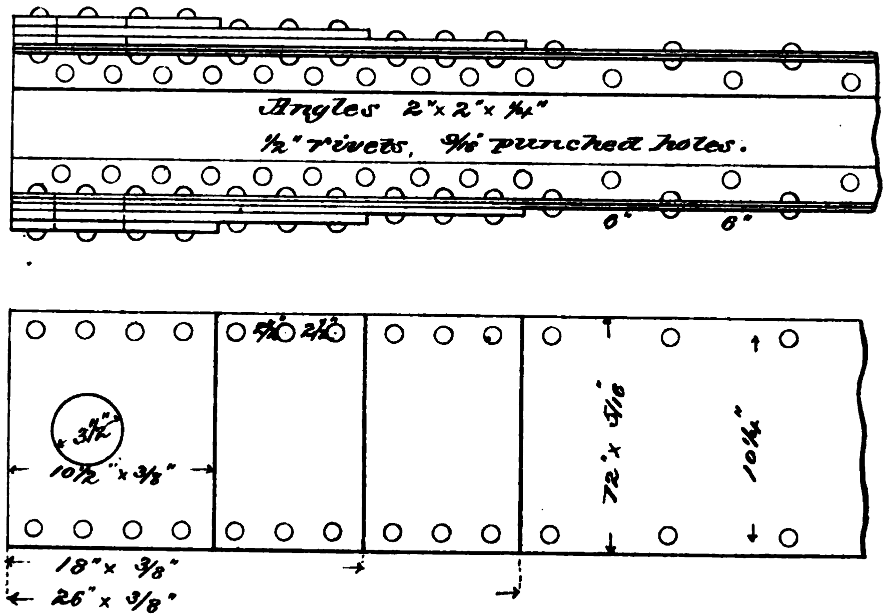
Pin holes in channel bar webs elongated .07″.

Pin holes in eye-plates elongated .03″.

Set F

General dimensions





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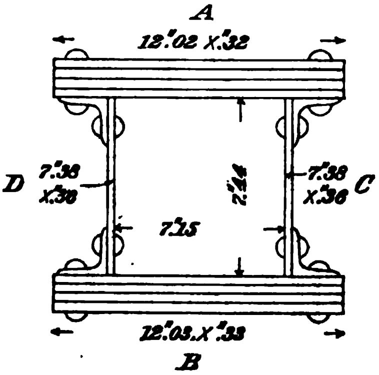
No. 346.—SET F.



(Tested with flat ends.)

Total length, 13′ 11″.9.
Gauged length (along center line, Plate A), 100″.
Total weight (includes eye-plates), 1,015 pounds.
Counter-weight at middle, 507 pounds.

Sectional area.

	Square inches.
Upper plate A, 14′; weight, 184 pounds	3.94
Under plate B, 14′; weight, 176 pounds	3.77
Side plate C, 14′; weight, 106 pounds	2.27
Side plate D, 14′; weight, 101 pounds	2.16
Four angles, each 14′; weight, 42 pounds	3.60
	15.74

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0014	....	0.	0.	
20,000	....	.0038	....	0.	0.	
30,000	....	.0059	....	0.	0.	
40,000	....	.0082	....	0.	0.	
50,000	....	.0102	....	0.	0.	
5,000	....	....	—.0001	0.	0.	
60,000	....	.0123	....	0.	0.	
70,000	....	.0146	....	0.	0.	
80,000	....	.0168	....	—.01	0.	
90,000	....	.0189	....	—.01	0.	
100,000	....	.0211	....	—.01	0.	
5,000	....	....	—.0002	0.	0.	
110,000	....	.0232	....	—.01	0.	
120,000	....	.0255	....	—.01	0.	
130,000	....	.0276	....	—.01	0.	
140,000	....	.0300	....	—.01	0.	
150,000	....	.0321	....	—.01	0.	
5,000	....	....	—.0002	0.	0.	
160,000	....	.0344	....	—.01	0.	
170,000	....	.0366	....	—.01	0.	
180,000	....	.0388	....	—.01	0.	
190,000	....	.0410	....	—.01	0.	
200,000	....	.0434	....	—.01	0.	
5,000	....	....	—.0002	0.	0.	
210,000	....	.0457	....	—.01	0.	
220,000	....	.0478	....	—.02	0.	
230,000	....	.0501	....	—.02	0.	
240,000	....	.0525	....	—.02	0.	
250,000	....	.0548	....	—.02	0.	
5,000	....	....	+.0002	0.	0.	
260,000	....	.0571	....	—.02	0.	

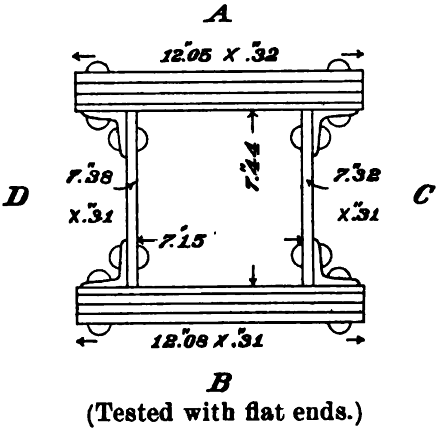
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
270,000		.0594		—.02	0.	
280,000		.0618		—.02	0.	
290,000		.0643		—.02	0.	Snapping sounds.
300,000		.0668		—.02	0.	
5,000			.0010	0.	0.	
310,000		.0691		—.02	0.	
320,000		.0717		—.02	0.	
330,000		.0740		—.02	0.	
340,000		.0766		—.03	0.	
350,000		.0791		—.03	0.	
5,000			.0021	0.	0.	
360,000		.0818		—.03	0.	
370,000		.0843		—.03	0.	
380,000		.0870		—.03	0.	
390,000		.0899		—.03	0.	
400,000		.0924		—.03	0.	
5,000			.0040	0.	0.	
410,000		.0953		—.03	0.	
420,000		.0981		—.03	0.	
430,000		.1013		—.03	0.	
440,000		.1041		—.03	0.	
450,000		.1071		—.03	0.	
5,000			.0073	0.	0.	
460,000		.1108		—.03	0.	
470,000		.1139		—.03	0.	
480,000		.1180		—.03	0.	
490,000		.1220		—.03	0.	
500,000		.1262		—.03	0.	
5,000			.0158	0.	0.	
510,000		.1313		—.03	0.	
517,000	32,846					Ultimate strength.

Failed by buckling-plates at a distance of 30″ to 36″ from one end, close by the eye-plates.

The upper and lower plates bent outward, the side plates inward.

The sustaining power fell off rapidly after buckling of the plates took place.

No. 347.—Set F.



(Tested with flat ends.)

Total length, 13′ 11″.65.
Gauged length (along center line, Plate A), 100″.
Total weight (includes eye-plates), 1,015 pounds.
Counter-weight at middle, 507 pounds.

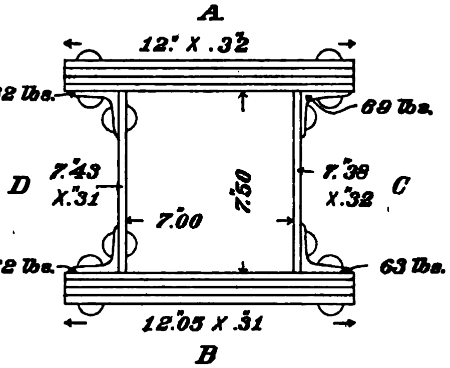
Sectional area.

	Square inches.
Upper plate A, 14′; weight, 178 pounds	3.81
Upper plate B, 14′; weight, 190 pounds	4.07
Side plate C, 14′; weight, 102 pounds	2.18
Side plate D, 14′; weight, 102 pounds	2.18
Four angles, each 14′; weight, 42 pounds	3.60
Total	15.84

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5, 000	...	0.	0.	0.	0.	Initial load.
10, 000	...	.0004	...	0.	0.	
20, 000	...	.0024	...	0.	0.	
30, 000	...	.0044	...	0.	0.	
40, 000	...	.0064	...	0.	0.	
50, 000	...	.0084	...	0.	0.	
5, 000	...	...	—.0001	0.	0.	
60, 000	...	.0105	...	0.	0.	
70, 000	...	.0123	...	0.	0.	
80, 000	...	.0145	...	0.	0.	
90, 000	...	.0167	...	0.	0.	
100, 000	...	.0189	...	0.	0.	
5, 000	...	...	—.0001	0.	0.	
110, 000	...	.0210	...	0.	0.	
120, 000	...	.0231	...	0.	.01	
130, 000	...	.0253	...	0.	.01	
140, 000	...	.0277	...	0.	.01	
150, 000	...	.0299	...	0.	.01	
5, 000	...	...	—.0001	0.	0.	
160, 000	...	.0321	...	0.	.01	
170, 000	...	.0343	...	0.	.01	
180, 000	...	.0366	...	—.01	.02	
190, 000	...	.0388	...	—.01	.02	
200, 000	...	.0409	...	—.01	.02	
5, 000	...	...	—.0001	0.	0.	
210, 000	...	.0433	...	—.01	.02	
220, 000	...	.0455	...	—.02	.02	
230, 000	...	.0476	...	—.02	.02	
240, 000	...	.0500	...	—.02	.02	
250, 000	...	.0522	...	—.02	.02	
5, 000	...	...	—.0002	0.	0.	
260, 000	...	.0546	...	—.02	.02	
270, 000	...	.0569	...	—.02	.02	
280, 000	...	.0592	...	—.02	.02	
290, 000	...	.0614	...	—.02	.02	Snapping sounds.
300, 000	...	.0638	...	—.02	.02	
5, 000	...	...	+.0002	0.	0.	
310, 000	...	.0661	...	—.02	.02	
320, 000	...	.0684	...	—.02	.02	
330, 000	...	.0709	...	—.02	.02	
340, 000	...	.0732	...	—.02	.02	Snapping sounds repeated.
350, 000	...	.0757	...	—.02	.02	
5, 000	...	...	.0010	0.	0.	
360, 000	...	.0780	...	—.02	.02	
370, 000	...	.0805	...	—.02	.02	
380, 000	...	.0830	...	—.02	.02	
390, 000	...	.0855	...	—.02	.02	
400, 000	...	.0882	...	—.02	.02	
5, 000	...	...	.0029	0.	0.	
410, 000	...	.0913	...	—.02	.02	
420, 000	...	.0937	...	—.02	.02	
430, 000	...	.0962	...	—.03	.02	
440, 000	...	.0990	...	—.03	.02	
450, 000	...	.1022	...	—.03	.02	
5, 000	...	...	.0050	0.	0.	
460, 000	...	.1050	...	—.03	.02	
470, 000	...	.1080	...	—.03	.02	
480, 000	...	.1117	...	—.03	.02	
490, 000	...	.1148	...	—.03	.02	
500, 000	...	.1183	...	—.03	.02	
5, 000	...	...	.0094	0.	0.	
519, 000	...	.1220	...	—.03	.02	
520, 000	...	.1264	...	—.03	.02	
530, 000	...	.1309	...	—.03	.02	
540, 000	...	.1352	...	—.03	.02	
550, 000	...	.1405	...	—.03	.03	
5, 000	...	...	.0194	—.01	.01	
555, 200	35, 050	.1498	...	—.03	0.	Ultimate strength.

Failed by buckling the upper plate 20″ from the middle of the length of the post and buckling the under plate 30″ from the end of the post. The strength of the post fell off rapidly after buckling began.

No. 342.—Set F.



(Tested with flat ends.)

Total length, 20′ 7⅝″
Gauged length (along center line, Plate A), 180″.
Total weight (includes eye-plates), 1,378 pounds.
Counter-weight at middle, 689 pounds.

Sectional area.

	Square inches.
Upper plate A, 20′ 8″; weight, 262 pounds	3.80
Under plate B, 20′ 8″; weight, 257 pounds	3.73
Side plate C, 20′ 8″; weight, 154 pounds	2.23
Side plate D, 20′ 8″; weight, 152 pounds	2.21
Four angles, 20′ 8″; weight, 256 pounds	3.71
Total	15.68

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000	....	0.	0.	0.	0.	Initial load.
10,000	....	.0020	....	0.	0.	
20,000	....	.0066	....	0.	0.	
30,000	....	.0106	....	0.	0.	
40,000	....	.0146	....	0.	0.	
50,000	....	.0186	....	0.	0.	
5,000	....	....	.0004	0.	0.	
60,000	....	.0222	....	0.	0.	
70,000	....	.0262	....	0.	0.	
80,000	....	.0300	....	0.	0.	
90,000	....	.1339	....	0.	0.	
100,000	....	.0381	....	0.	0.	
5,000	....	....	.0004	0.	0.	
110,000	....	.0422	....	0.	0.	
120,000	....	.0462	....	0.	0.	
130,000	....	.0503	....	0.	0.	
140,000	....	.0543	....	0.	0.	
150,000	....	.0583	......	0.	0.	
5,000	....	....	.0004	0.	0.	
160,000	....	.0624	....	0.	0.	
170,000	....	.0664	....	0.	0.	
180,000	....	.0706	....	0.	0.	

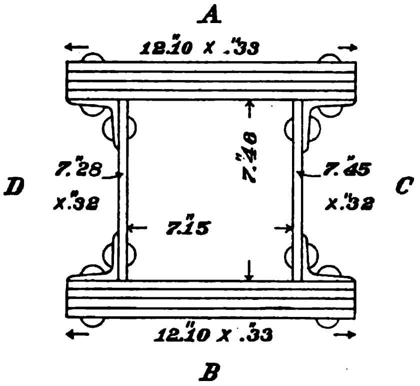
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
190, 000		.0746		0.	0.	
200, 000		.0788		0.	0.	
5, 000			.0009	0.	0.	
210, 000		.0830		0.	0.	
220, 000		.0870		0.	0.	
230, 000		.0911		0.	0.	
240, 000		.0954		0.	0.	
250, 000		.0997		0.	0.	
5, 000			.0018	0.	0.	
260, 000		.1039		0.	0.	
270, 000		.1079		0.	0.	
280, 000		.1123		0.	0.	
290, 000		.1167		0.	0.	
300, 000		.1209		0.	0.	
5, 000			.0026	0.	0.	
310, 000		.1255		0.	0.	
320, 000		.1300		0.	0.	
330, 000		.1346		0.	0.	
340, 000		.1391		0.	0.	
350, 000		.1439		0.	0.	
5, 000			.0047	0.	0.	
360, 000		.1490		0.	0.	
370, 000		.1535		0.	0.	
380, 000		.1583		0.	0.	
390, 000		.1630		0.	0.	
400, 000		.1685		0.	0.	
5, 000			.0068	0.	0.	
410, 000		.1738		0.	0.	
420, 000		.1792		0.	0.	
430, 000		.1842		0.	0.	
440, 000		.1906		0.	0.	
450, 000		.1964		0.	0.	
5, 000			.0161	0.	0.	
460, 000		.2080		0.	—.02	Snapping sounds.
470, 000		.2109		0.	—.02	
480, 000		.2177		0.	—.02	
490, 000		.2257		0.	—.02	
500, 000		.2340		0.	—.02	
5, 000			.0328	—.01	—.01	
510, 000		.2454		—.02	—.03	
517, 500	33, 003	.2639		+.04	—.06	Ultimate strength.
420, 000				—.06	.46	
380, 000				—.08	.80	
332, 000				—.10	1.00	
5, 000				—.06	1.01	Test discontinued.

Failed by deflecting upward, Plate A being on the convex side. The point of maximum upward deflection occurred 2½′ from the middle of the post.

Loads were continued till the upper and lower plates were buckled at the concave places. The angles and side plates were also distorted.

The sustaining power of the post fell off rapidly when the maximum load was passed, unaccompanied, however, with the sudden lateral springing observed in longer posts, or long posts with pin ends.

No. 344.—Set F.



(Tested with flat ends.)

Total length, 20′ 7″.80.
Gauged length (along center line plate A), 180″.
Total weight (includes eye-plates), 1,370 pounds.
Counter-weight at middle, 685 pounds.

Sectional area.

	Square inches.
Upper plate A, 20′ 8″; weight, 258 pounds	3.74
Under plate B, 20′ 8″; weight, 257 pounds	3.73
Side plate C, 20′ 8″; weight, 155 pounds	2.25
Side plate D, 20′ 8″; weight, 154 pounds	2.23
Four angles 20′ 8″; weight, 249 pounds	3.61
Total	15.56

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,000		0.	0.	0.	0.	Initial load.
10,000		.0019		0.	0.	
20,000		.0059		0.	0.	
30,000		.0099		—.01	0.	
40,000		.0139		—.01	0.	
50,000		.0179		—.01	0.	
5,000			0.	0.	0.	
60,000		.0219		—.02	0.	
70,000		.0259		—.02	0.	
80,000		.0299		—.03	0.	
90,000		.0339		—.03	0.	
100,000		.0379		—.03	0.	
5,000			0.	0.	0.	
110,000		.0420		—.04	0.	
120,000		.0463		—.04	0.	
130,000		.0503		—.04	0.	
140,000		.0544		—.04	0.	
150,000		.0585		—.04	0.	
5,000			0.	0.	0.	
160,000		.0623		—.04	0.	
170,000		.0665		—.05	0.	
180,000		.0705		—.05	0.	
190,000		.0745		—.05	0.	
200,000		.0788		—.06	0.	
5,000			0.	0.	0.	
210,000		.0829		—.06	0.	
220,000		.0871		—.06	0.	

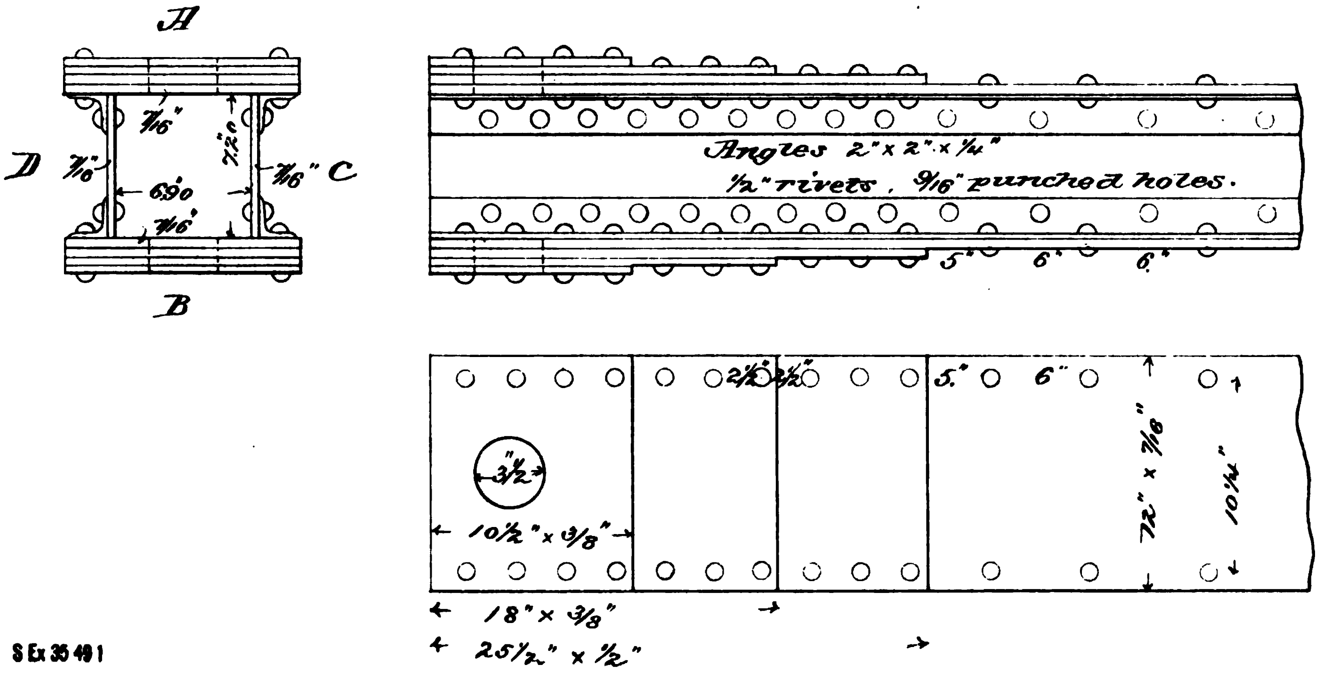
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
230,000	....	.0911	....	—.06	0.	
240,000	....	.0956	....	—.06	0.	
250,000	....	.0998	....	—.06	—.01	
5,000	....	....	0.	0.	0.	
260,000	....	.1040	....	—.06	—.01	
270,000	....	.1084	....	—.06	—.01	
280,000	....	.1127	....	—.06	—.01	
290,000	....	.1169	....	—.06	—.01	
300,000	....	.1211	....	—.06	—.01	
5,000	....	....	.0011	0.	0.	
310,000	....	.1256	....	—.07	—.01	
320,000	....	.1299	....	—.07	—.01	
330,000	....	.1344	....	—.07	—.01	
340,000	....	.1390	....	—.07	—.01	
350,000	....	.1439	....	—.08	—.02	
5,000	....	....	.0030	—.01	—.01	
360,000	....	.1483	....	—.08	—.02	
370,000	....	.1529	....	—.08	—.02	
380,000	....	.1576	....	—.08	—.03	
390,000	....	.1624	....	—.08	—.03	
400,000	....	.1673	....	—.09	—.03	
5,000	....	....	.0059	—.02	—.02	
410,000	....	.1721	....	—.10	—.03	
420,000	....	.1778	....	—.10	—.03	
430,000	....	.1829	....	—.10	—.03	
440,000	....	.1881	....	—.11	—.03	
450,000	....	.1936	....	—.11	—.03	
5,000	....	....	.0115	—.03	—.03	
460,000	....	.2002	....	—.12	—.03	
470,000	....	.2064	....	—.12	—.03	
480,000	....	.2129	....	—.12	—.03	
490,000	....	.2202	....	—.13	—.04	
500,000	....	.2298	....	—.13	—.04	
5,000	....	....	.0255	—.05	—.03	
510,000	....	.2375	....	—.15	—.04	
520,000	....	.2480	....	—.16	—.04	
530,000	....	.2610	....	—.17	—.05	Slight snapping sounds.
535,000	....	.2710	....	—.20	—.07	
536,900	34,505	.2819	....	—.22	—.08	Ultimate strength.
530,000	....	....	....	—.25	—.08	

Post failed by buckling the plates at a place 6 feet from the end.

The upper and lower plates took sharp buckles outward between the riveting; the side plates buckled inward.

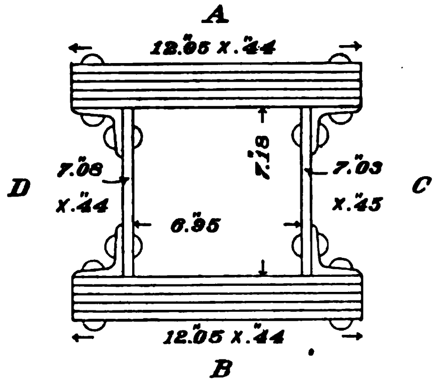
Set G

General dimensions



S Ex 35 49 1

No. 348.—SET G.



(Tested with flat ends.)

Total length, 13′ 11¾″.
Gauged length (along center line Plate A), 100″.
Total weight (includes eye-plates), 1,285 pounds.
Counter-weight at middle, 642 pounds.

Sectional area.

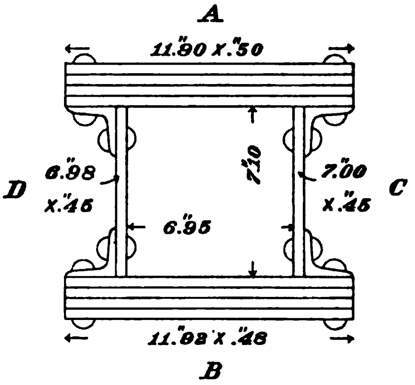
	Square inches.
Upper plate A, 14′; weight, 258 pounds	5.52
Under plate B, 14′; weight, 258 pounds	5.52
Side plate C, 14′; weight, 148 pounds	3.17
Side plate D, 14′; weight, 150 pounds	3.21
Four angles, each 14′; weight, 42 pounds	3.60
Total	21.02

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	.0	0.	0.	Initial load.
20,000	....	.0018	....	0.	0.	
40,000	....	.0043	....	0.	0.	
60,000	....	.0078	....	0.	0.	
80,000	....	.0103	....	0.	0.	
100,000	....	.0136	....	0.	0.	
10,000	....	....	.0003	0.	0.	
120,000	....	.0169	....	0.	0.	
140,000	....	.0202	....	—.01	0.	
160,000	....	.0232	....	—.01	0.	
180,000	....	.0268	....	—.01	0.	
200,000	....	.0302	....	—.01	0.	
10,000	....	....	.0005	0.	0.	
220,000	....	.0335	....	—.02	.01	
240,000	....	.0368	....	—.02	.01	
260,000	....	.0408	....	—.02	.01	
280,000	....	.0439	....	—.02	.01	
300,000	....	.0477	....	—.02	.01	Snapping sounds.
10,000	....	....	.0001	0.	0.	
320,000	....	.0511	....	—.02	.01	
340,000	....	.0547	....	—.03	.02	
360,000	....	.0582	....	—.03	.02	
380,000	....	.0617	....	—.03	.02	
400,000	....	.0652	....	—.03	.02	
10,000	....	....	.0007	0.	0.	
420,000	....	.0689	....	—.03	.02	
440,000	....	.0729	....	—.03	.02	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
460,000	....	.0766	....	—.04	.02	
480,000	....	.0804	....	—.06	0.	
500,000	....	.0843	....	—.07	0.	
10,000	....	....	.0021	—.07	0.	
520,000	....	.0886	....	—.07	0.	
540,000	....	.0927	....	—.07	0.	
560,000	....	.0969	....	—.08	0.	
580,000	....	.1017	....	—.09	0.	
600,000	....	.1060	....	—.09	0.	
10,000	....	....	.0065	—.07	0.	
620,000	....	.1113	....	—.10	0.	
640,000	....	.1168	....	—.11	0.	
660,000	....	.1231	....	—.12	0.	
680,000	....	.1301	....	—.13	.01	
700,000	....	.1450	....	—.16	.03	
10,000	....	....	.0237	—.10	.03	
708,000	33,682	....	....	....	....	Ultimate strength.

Failure began by buckling the upper plate between the riveting 30 inches from the end of the post, close by the eye-plates. This gave an upward direction to the middle of the post, and was followed by buckling of the upper plate at a corresponding place at the opposite end. The under plate also buckled 15 inches from the middle of its length.

No. 349.—Set G.



(Tested with flat ends.)

Total length, 13′ 11¾″.
Gauged length (along center line plate A), 100″.
Total weight (includes eye-plates), 1,315 pounds.
Counter-weight at middle, 657 pounds.

Sectional area.

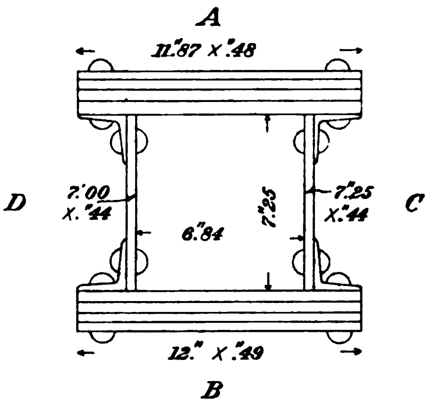
	Square inches.
Upper plate A, 14′; weight, 270 pounds	5.78
Under plate B, 14′; weight, 270 pounds	5.78
Side plate C, 14′; weight, 147 pounds	3.15
Side plate D, 14′; weight, 147 pounds	3.15
Four angles, each 14′; weight, 42 pounds	3.60
Total	21.46

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0014	....	0.	0.	
40,000	....	.0044	....	0.	0.	
60,000	....	.0076	....	0.	0.	
80,000	....	.0105	....	0.	0.	
100,000	....	.0137	....	0.	0.	
10,000	....	....	0.	0.	0.	
120,000	....	.0168	....	0.	0.	
140,000	....	.0202	....	0.	0.	
160,000	....	.0232	....	0.	0.	
180,000	....	.0268	....	—.01	0.	
200,000	....	.0299	....	—.01	0.	
10,000	....	....	0.	0.	0.	
220,000	....	.0330	....	—.01	0.	
240,000	....	.0366	....	—.02	0.	
260,000	....	.0401	....	—.02	0.	
280,000	....	.0434	....	—.03	0.	Snapping sounds.
300,000	....	.0469	....	—.03	0.	
10,000	....	....	.0007	0.	0.	
320,000	....	.0503	....	—.03	0.	
340,000	....	.0538	....	—.03	0.	
360,000	....	.0571	....	—.03	0.	
380,000	....	.0607	....	—.03	0.	
400,000	....	.0643	....	—.03	0.	
10,000	....	....	.0013	0.	0.	
420,000	....	.0678	....	—.03	0.	
440,000	....	.0711	....	—.03	0.	
460,000	....	.0748	....	—.03	0.	
480,000	....	.0784	....	—.04	0.	
500,000	....	.0822	....	—.04	0.	
10,000	....	....	.0032	0.	0.	
520,000	....	.0863	....	—.05	0.	
540,000	....	.0902	....	—.05	0.	
560,000	....	.0948	....	—.06	0.	
580,000	....	.0990	....	—.06	0.	
600,000	....	.1049	....	—.06	0.	
10,000	....	....	.0060	0.	0.	
620,000	....	.1086	....	—.07	0.	
640,000	....	.1142	....	—.07	0.	
660,000	....	.1206	....	—.07	0.	
680,000	....	.1286	....	—.09	0.	
700,000	....	.1410	....	—.14	.02	
10,000	....	....	.0284	—.08	.01	
709,500	33,061	....	....	—.25	.40	Ultimate strength.

Failed by triple flexure; middle deflection taking place in an upward direction, with plate A on the convex side.

When the middle deflection reached ″.50 vertical, the upper and lower plates began to buckle between the riveting at the concave places.

No. 341.—Set G.



(Tested with flat ends.)

Total length, 20′ 7″.6.
Gauged length (along center line plate A), 180″.
Total weight (includes eye-plates), 1,790 pounds.
Counter-weight at middle, 895 pounds.

Sectional area.

	Square inches.
Upper plate A, 20′ 8″; weight, 397 pounds	5.76
Under plate B, 20′ 8″; weight, 401 pounds	5.82
Side plate C, 20′ 8″; weight, 209 pounds	3.03
Side plate D, 20′ 8″; weight, 206 pounds	2.99
Four angles, each 20′ 8″; weight, 62 pounds	3.60
Total	21.20

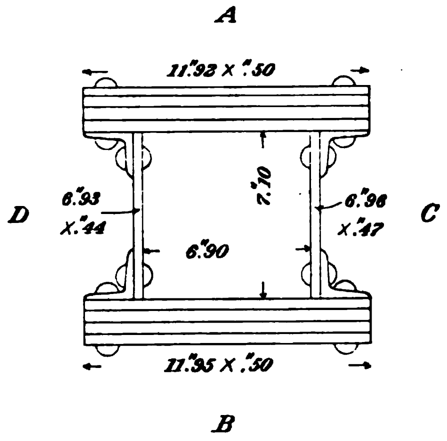
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inches.*	
10,000	....	0.	....	0.	0.	Initial load.
20,000	....	.0022	....	0.	0.	
40,000	....	.0076	....	0.	0.	
60,000	....	.0132	....	—.01	0.	
80,000	....	.0189	....	—.01	0.	
100,000	....	.0248	....	—.01	0.	
10,000	....	....	0.	0.	0.	
120,000	....	.0306	....	—.01	.02	
140,000	....	.0366	....	—.01	.02	
160,000	....	.0428	....	—.01	.02	
180,000	....	.0488	....	—.02	.02	
200,000	....	.0544	....	—.02	.02	
10,000	....	....	0.	0.	0.	
220,000	....	.0605	....	—.02	.02	
240,000	....	.0666	....	—.02	.02	
260,000	....	.0726	....	—.02	.02	
280,000	....	.0789	....	—.02	.02	
300,000	....	.0848	....	—.02	.02	
10,000	....	....	.0009	0.	0.	
320,000	....	.0912	....	—.02	.02	
340,000	....	.0974	....	—.02	.02	
360,000	....	.1032	....	—.02	.02	
380,000	....	.1097	....	—.02	.02	
400,000	....	.1158	....	—.03	.03	
10,000	....	....	.0022	0.	0.	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
420,000		.1222		—.03	.03	
440,000		.1286		—.03	.03	
460,000		.1351		—.03	.03	
480,000		.1417		—.03	.03	
500,000		.1488		—.03	.03	
10,000			.0053	0.	0.	
520,000		.1555		—.03	.03	
540,000		.1625		—.03	.03	
560,000		.1702		—.03	.03	
580,000		.1778		—.03	.03	
600,000		.1858		—.03	.03	
10,000			.0128	—.02	.02	
620,000		.1952		—.03	.03	
640,000		.2047		—.03	.03	
660,000		.2154		—.03	.03	
680,000		.2288		—.03	.03	
700,000		.2452		+.02	.07	
10,000			.0410	0.	.04	
700,000	33,019			.08	.19	Ultimate strength.
640,000				.12	1.00	
620,000				.14	1.50	
590,000				.17	2.00	
10,000				.10	1.68	

Deflected upwards, plate A being on the convex side. The maximum deflection occurred 15'' from the middle of the column. Deflection continued till the under plate B buckled between the rivets.

The plate was buckled ⅛'', with no apparent injury to the angle iron to which it was riveted.

No. 343.—Set G.



(Tested with flat ends.)

Total length, 20' 7⅝''.
Gauged length (along center line, plate A), 180''.
Total weight (includes eye-plates), 1,840 pounds.
Counter-weight at middle, 920 pounds.

Sectional area.

	Square inches.
Upper plate A, 20′ 8″; weight, 397 pounds	5.76
Under plate B, 20′ 8″; weight, 405 pounds	5.88
Side plate C, 20′ 8″; weight, 224 pounds	3.25
Side plate D, 20′ 8″; weight, 207 pounds	3.00
Four angles, each 20′ 8″; weight, 62 pounds	3.60
	21.49

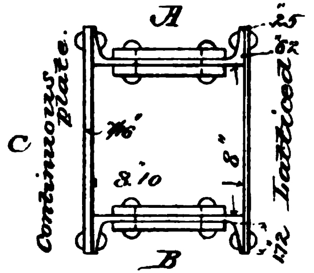
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000		0.	0.	0.	0.	Initial load.
20,000		.0022		0.	0.	
40,000		.0079		0.	0.	
60,000		.0133		0.	—.02	
80,000		.0190		0.	—.02	
100,000		.0249		0.	—.02	
10,000			.0006	0.	0.	
120,000		.0306		0.	—.02	
140,000		.0364		0.	—.02	
160,000		.0422		0.	—.02	
180,000		.0483		0.	—.02	
200,000		.0540		0.	—.02	
10,000			.0000	0.	0.	
220,000		.0600		0.	—.02	
240,000		.0660		0.	—.02	
260,000		.0720		0.	—.02	
280,000		.0780		0.	—.02	
300,000		.0844		0.	—.02	
10,000			.0010	0.	0.	
320,000		.0907		0.	—.02	Slight, snapping sound.
340,000		.0970		0.	—.02	
360,000		.1032		0.	—.02	
380,000		.1094		0.	—.02	
400,000		.1158		0.	—.02	
10,000			.0029	0.	0.	
420,000		.1217		0.	—.02	
440,000		.1280		0.	—.02	
460,000		.1346		0.	—.02	
480,000		.1410		0.	—.02	
500,000		.1480		0.	—.02	
10,000			.0060	0.	—.02	
520,000		.1547		—.01	—.02	
540,000		.1617		—.01	—.02	
560,000		.1689		—.01	—.02	
580,000		.1762		—.01	—.02	Snapping sounds repeated.
600,000		.1840		—.01	—.02	
10,000			.0123	—.02	—.02	
620,000		.1923		—.02	—.02	
640,000		.2015		—.02	—.02	
660,000		.2110		—.02	—.02	
670,000		.2158		—.02	—.02	
680,000		.2214		—.02	—.02	
690,000		.2274		—.02	—.02	
700,000		.2339		—.03	—.02	
10,000			.0318	—.03	—.03	
710,000		.2422		—.03	—.03	
720,000		.2498		—.03	—.03	
729,450	33,943			—.08 —.18	—.03 —.04	Ultimate strength.
728,000				—.20	—.10	
100,000				—.20	—.06	

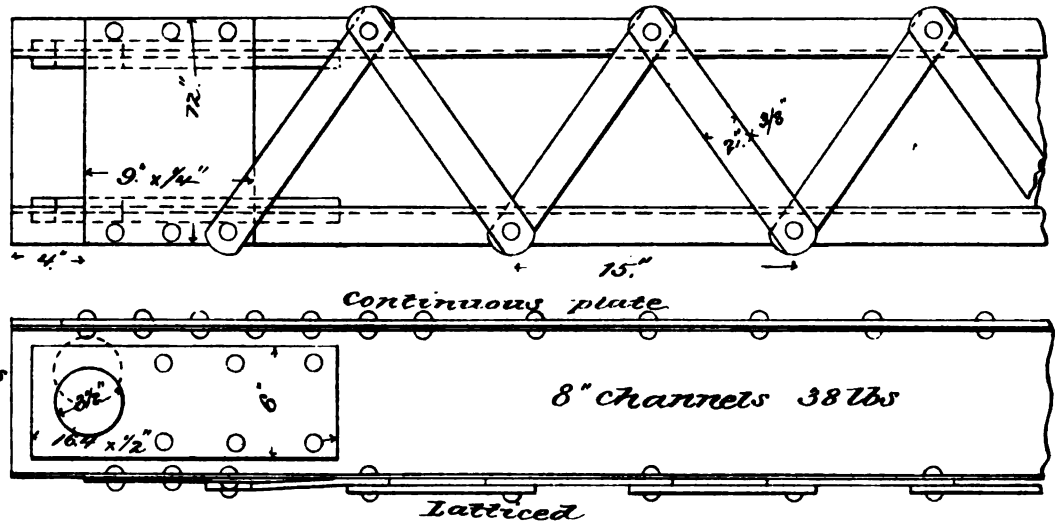
After the maximum load had been passed, and the post was gradually deflecting under 728,000 pounds pressure, the load was released to 108,000 pounds, and the post allowed to rest 15 hours.

At the expiration of this time, 105,000 pounds load was found on the post; the difference of 3,000 pounds, representing the falling off of pressure due to the leakage of the hydraulic packings, and the change in temperature of the oil—which cooled during the night.

Set K

General dimensions.





Dotted circle shows position of pin-holes Columns 352, 353

S Ex 35 49 1

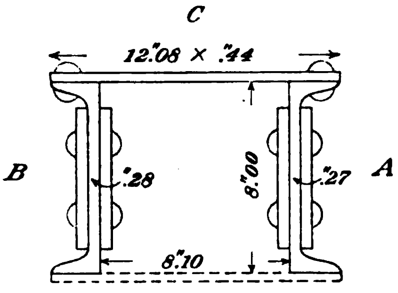
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
728,000	....	....	....	—.21	—.08	
730,600	.. ..	....	....	—.22	—.08	
732,600	34,090	.....	....	—.22	—.10	Maximum load after 15 hours' rest.
708,000	....	....	....	—.23	—.33	Upper plate begins to buckle on concave side of post.
650,000	....	....	....	—.22	—.63	
594,000	....	....	....	—.22	—1.00	
10,000	....	....	......	—.23	—1.15	Test discontinued.

Maximum deflection occurred 15 inches from middle of post.

Failed by deflecting downward; plate B on the convex side.

The effect of 15 hours' rest on the ultimate resistance of the post appears to have been 4,600 pounds—the difference between 728,000 and 732,600 pounds.

No. 339.—Set K.



(Tested with flat ends.)

Total length, 20′ 7″.94.

Gauged length (along centre of continuous plate), 200″.

Total weight (includes eight eye-plates), 1,115 pounds.

Counter-weight at middle, 558 pounds.

Sectional area.

	Square inches.
Channel A, 20′ 8″; weight, 259 pounds; web, ″.27	3.76
Channel B, 20′ 8″; weight, 260 pounds; web, ″.28	3.77
Continuous plate, 20′ 8″; weight, 352 pounds	5.11
Total	12.64

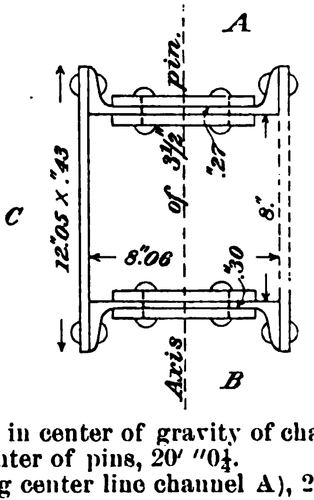
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
290,000		.1561		—.04	.04	
300,000		.1620		—.05	.04	
5,000			.0027	0.	0.	
310,000		.1683		—.05	.04	
320,000		.1739		—.05	.04	
330,000		.1806		—.05	.04	
340,000		.1869		—.05	.04	
350,000		.1937		—.05	.05	
5,000			.0074	—.01	.01	
360,000		.2014		—.06	.06	
370,000		.2098		—.07	.07	
380,000		.2178		—.07	.07	
390,000		.2258		—.07	.08	
400,000		.2357		—.08	.09	
5,000			.0210	—.04	.04	
410,000		.2464		—.09	.10	
415,000						Snapping sounds.
420,000		.2580		—.13	.13	
430,000		.2685		—.17	.18	
431,400	33,862			—.23	.30	Ultimate strength.
420,000				—.28	.65	
409,000				—.28	1.00	
386,000				—.29	2.00	
374,000				—.30	2.50	
358,000				—.30	3.00	
5,000				—.30	2.70	Test discontinued.

Deflected upward at middle, the continuous plate being on the convex side.

When the middle deflection had reached 3″.00 vertical, the flat ends left their bearings ″.02 at the under or latticed side of the post. The flanges of the channels were buckled along the middle of the post on the latticed side.

The lattice-bars were not buckled.

No. 350.—Set K.



Tested with 3½″ pins in center of gravity of channel-bars.
Length, center to center of pins, 20′ ″0¼.
Gauged length (along center line channel A), 200″.
Total weight, 1,110 pounds.
Counter-weight at middle, 555 pounds.

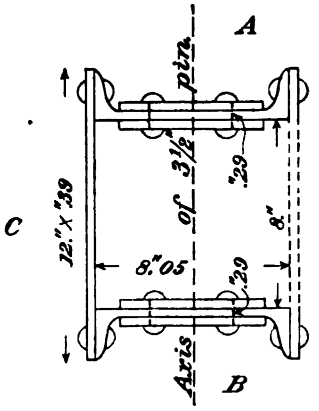
Sectional area.

	Square inches.
Channel A, 20′ 8″; weight, 251 pounds; web, ″.27	3.64
Channel B, 20′ 8″; weight, 261 pounds; web, ″.30	3.79
Continuous plate C, 20′ 8″; weight, 348 pounds	5.05
Total	12.48

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0069	....	.03	0.	
30,000	....	.0144	....	.07	0.	
40,000	....	.0213	....	.11	0.	
50,000	....	.0292	....	.14	0.	
10,000	....	....	.0003	.02	0.	
60,000	....	.0364	....	.18	0.	
70,000	....	.0440	....	.22	0.	
80,000	....	.0520	....	.28	0.	
90,000	....	.0599	....	.32	0	
100,000	....	.0682	....	.37	0.	
10,000	....	....	.0007	.02	0.	
110,000	....	.0764	....	.43	0.	
120,000	....	.0849	....	.47	0.	
130,000	....	.0939	....	.53	0.	
140,000	....	.1024	....	.59	0.	
150,000	....	.1117	....	.67	0.	
10,000	....	....	.0014	.02	0.	
160,000	....	.1213	....	.73	.01	
170,000	....	.1310	....	.82	.01	
180,000	....	.1418	....	.90	.03	
190,000	....	.1538	....	1.02	.03	
200,000	....	.1716	....	1.20	.03	
10,000	....	....	.0140	.15	0.	
202,700	16,242	....	....	1.40	.06	Ultimate strength.
190,000	....	....	....	1.90	.07	
180,000	....	....	....	2.30	.08	
165,000	....	....	....	3.00	.09	
140,000	....	....	....	4.00	.09	
10,000	....	....	....	2.80	.09	

Column failed by horizontal deflection; concave on the latticed side.

No. 351.—SET K.



(Tested with 3½″ pins in center of gravity of channel-bars.)

Length, center to center of pins, 20′—0″.
Gauged length (along channel A in plane of 3½″ pins), 200″.
Total weight, 1,078 pounds.
Counter-weight at middle, 539 pounds.

Sectional area.

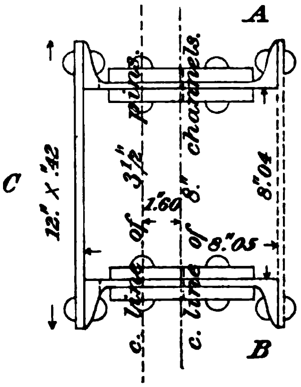
	Square inch.
Channel A, 20′ 8″; weight, 257 pounds; web, ″.29	3.73
Channel B, 20′ 8″; weight, 260 pounds; web ″.29	3.77
Plate C, 20′ 8″; weight, 230 pounds	3.34
Total	10.84

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0063	....	.02	0.	
30,000	....	.0138	....	.05	0.	
40,000	....	.0208	....	.08	0.	
50,000	....	.0280	....	.12	0.	
10,000	....	....	—.0008	0.	0.	
60,000	....	.0350	....	.15	0.	
70,000	....	.0425	....	.18	0.	
80,000	....	.0502	....	.23	0.	
90,000	....	.0590	....	.26	0.	
100,000	....	.0660	....	.32	0.	
10,000	....	....	—.0008	.01	0.	
110,000	....	.0743	....	.36	0.	
120,000	....	.0825	....	.43	0.	
130,000	....	.0910	....	.47	0.	
140,000	....	.0998	....	.53	0.	
150,000	....	.1081	....	.58	0.	
10,000	....	....	.0001	.01	0.	
160,000	....	.1178	....	.67	0.	
170,000	....	.1276	....	.74	0.	
180,000	....	.1376	....	.82	0.	
190,000	....	.1498	....	.93	0.	
200,000	....	.1631	....	1.05	0.	
10,000	....	....	.0081	.12	0.	
208,200	19,207	.1882	....	1.38	—.01	Ultimate strength.
200,000	....	....	....	1.70	—.03	
191,000	....	....	....	2.00	—.04	
168,000	....	....	....	3.00	—.06	
152,000	....	....	....	4.00	—.08	
10,000	....	....	....	2.58	—.08	

Failed by horizontal deflection, perpendicular to the plane of the 3½″ pins.

The latticing is on the concave side.

No. 352.—Set K.



(Tested with 3½-inch pins in center of gravity of cross-section of metal of channel bars and continuous plate.)

Length, center to center, of pins, 20′ 0¼″.
Gauged length (along channel A in plane of pins), 200″.
Total weight, 1,120 pounds.
Counter-weight at middle, 560 pounds.

Sectional area.

	Square inches.
Channel A, 20′ 8″; weight, 260 pounds; web, ″.30	3.77
Channel B, 20′ 8″; weight, 260 pounds; web, ″.30	3.77
Plate C, 20′ 8″; weight, 352 pounds	5.11
Total	12.65

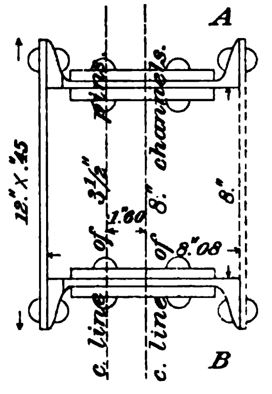
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inches.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0059	....	0.	0.	
30,000	....	.0117	....	0.	0.	
40,000	....	.0173	....	0.	0.	
50,000	....	.0229	....	.01	0.	
10,000	....	....	.0005	0.	0.	
60,000	....	.0287	....	.01	0.	
70,000	....	.0341	....	.01	0.	
80,000	....	.0398	....	.01	0.	
90,000	....	.0457	....	.02	0.	
100,000	....	.0518	....	.02	0.	
10,000	....	....	.0008	0.	0.	
110,000	....	.0569	....	.03	0.	
120,000	....	.0627	....	.03	0.	
130,000	....	.0684	....	.04	0.	
140,000	....	.0744	....	.04	0.	
150,000	....	.0804	....	.04	0.	
10,000	....	....	.0018	0.	0.	
160,000	....	.0861	....	.05	—.02	
170,000	....	.0920	....	.05	—.02	
180,000	....	.0979	....	.06	—.02	
190,000	....	.1038	....	.07	—.02	
200,000	....	.1098	....	.07	—.02	
10,000	....	....	.0026	0.	0.	
210,000	....	.1156	....	.07	—.03	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inches.*	*Inch.*	
220, 000	....	.1217	....	.07	—.03	
230, 000	....	.1278	....	.08	—.03	
240, 000	....	.1338	....	.10	—.03	
250, 000	....	.1400	....	.11	—.04	
10, 000	....	....	.0042	—.01	0.	
260, 000	....	.1464	....	.10	—.04	
270, 000	....	.1528	....	.11	—.04	
280, 000	....	.1590	....	.13	—.05	
290, 000	....	.1656	....	.14	—.05	
300, 000	....	.1720	....	.16	—.06	
10, 000	....	....	.0077	—.02	—.01	
310, 000	....	.1787	....	.13	—.06	
320, 000	....	.1868	....	.17	—.07	
330, 000	....	.1970	....	.23	—.08	
340, 000	....	.2071	....	.32	—.10	
345, 000	....	....	....	....	....	Snapping sounds.
350, 000	27, 668	.2252	....	.55	—.13	Ultimate strength.
336, 000	....	....	....	.80	—.13	
328, 000	....	....	....	1.00	—.18	
310, 000	....	....	....	2.00	....	Deflected rapidly.
235, 000	....	....	....	2.50	....	
215, 000	....	....	....	3.00	....	
10, 000	....	....	....	2.50	....	

Failed by horizontal deflection; concave on the latticed side of the column.

Pin-holes elongated ″.03 each.

No. 353.—Set K.



(Tested with 3½-inch pins, in center of gravity of cross-section of metal of channel bars and continuous plate.)

Length, center to center, of pins, 20′ 0¼″.
Gauged length (along center line of channel A), 200″.
Total weight, 1,125 pounds.
Counter-weight at middle, 562 pounds.

Sectional area.

	Square inches.
Channel A, 20′ 8″; weight, 265 pounds; web, ″.31	3.85
Channel B, 20′ 8″; weight, 262 pounds; web, ″.30	3.80
Plate C, 20′ 8″; weight, 352 pounds	5.11
Total	12.76

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inches.*	*Inch.*	
10,000	....	0.	0.	0.	0.	Initial load.
20,000	....	.0050	....	0.	0.	
30,000	....	.0104	....	0.	0.	
40,000	....	.0160	....	0.	0.	
50,000	....	.0210	....	0.	0.	
10,000	....	....	0.	0.	0.	
60,000	....	.0264	....	0.	0.	
70,000	....	.0320	....	0.	0.	
80,000	....	.0373	....	0.	0.	
90,000	....	.0428	....	0.	0.	
100,000	....	.0485	....	0.	0.	
10,000	....	....	0.	0.	0.	
110,000	....	.0539	....	0.	0.	
120,000	....	.0594	....	0.	0.	
130,000	....	.0649	....	0.	0.	
140,000	....	.0704	....	0.	0.	
150,000	....	.0758	....	0.	0.	
10,000	....	....	0.	0.	0.	
160,000	....	.0810	....	0.	0.	
170,000	....	.0864	....	0.	0.	
180,000	....	.0923	....	0.	0.	
190,000	....	.0980	....	0.	0.	
200,000	....	.1035	....	0.	0.	
10,000	....	....	—.0001	0.	0.	
210,000	....	.1091	....	0.	0.	
220,000	....	.1150	....	0.	0.	
230,000	....	.1206	....	0.	0.	
240,000	....	.1264	....	.01	0.	
250,000	....	.1324	....	.02	0.	
10,000	....	....	.0009	0.	0.	
260,000	....	.1382	....	.02	0.	
270,000	....	.1439	....	.02	0.	
280,000	....	.1492	....	.03	0.	
290,000	....	.1549	....	.04	0.	
300,000	....	.1605	....	.04	0.	
10,000	....	....	.0011	— .02	0.	
310,000	....	.1663	....	.03	0.	
320,000	....	.1732	....	.03	0.	
330,000	....	.1802	....	.05	0.	
340,000	....	.1884	....	.06	—.01	
345,000	....	....	....	....	....	Snapping sounds.
350,000	....	.1966	....	.07	—.02	
10,000	....	....	.0084	— .07	0.	
350,000	....	.1975	....	.03	—.02	
360,000	....	.2042	....	.04	—.03	
370,000	....	.2122	....	— .10	—.03	
380,000	....	.2202	....	— .20	—.04	
390,000	....	.2335	....	— .60	—.08	
390,400	30,596	....	....	— .70	—.08	Ultimate strength.
382,000	....	....	....	—1.00	....	
300,000	....	....	....	—3.00	....	

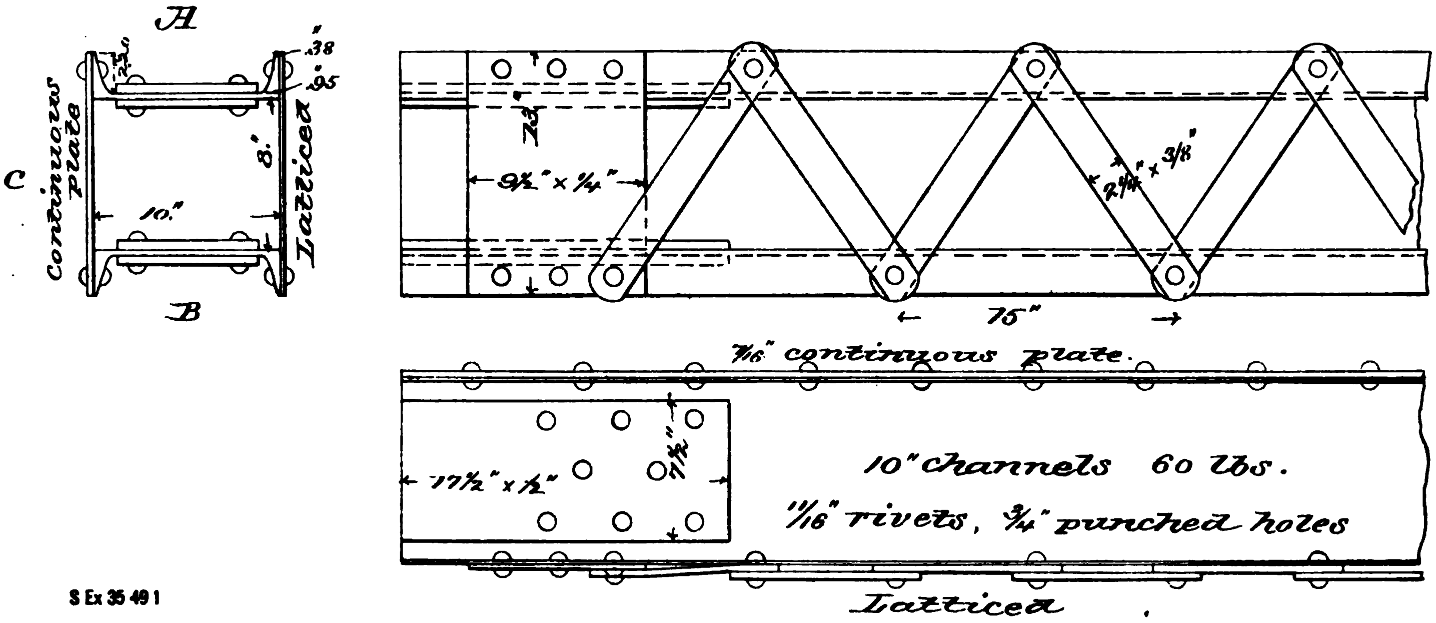
Failed by horizontal deflection, perpendicular to the plane of the pins. Convex on the latticed side.

Pin-holes elongated ″.08 each.

The channels and plate took a sharp bend about 16 inches from centers of pin-holes.

Set N

General dimensions



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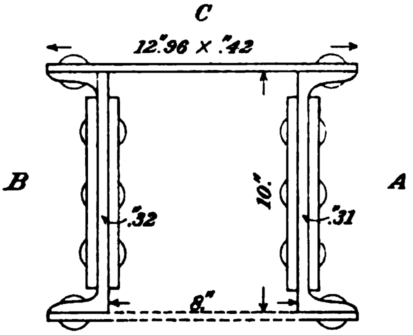
No. 337.—Set N.



(Tested with flat ends.)

Total length, 25′ 7¾″.
Gauged length (along center of continuous Plate C), 260″.
Total weight (includes 8 eye-plates), 1,844 pounds.
Counter-weight at middle, 922 pounds.

Sectional area.

	Square inches.
Channel A, 25′ 8½″; weight, 500 pounds; web, ″.31	5.83
Channel B, 25′ 8¾″; weight, 525 pounds; web, ″.32	6.12
Continuous plate, 25″ 8½′; weight, 432 pounds	5.04
Total	16.99

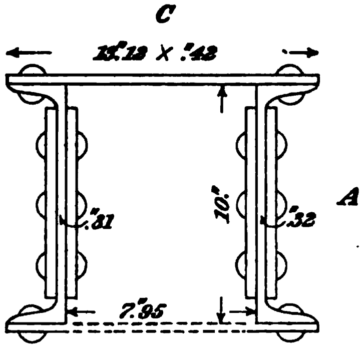
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000		0.	0.	0.	0.	Initial load.
20,000		.0048		0.	0.	
30,000		.0098		0.	0.	
40,000		.0148		0.	0.	
50,000		.0197		0.	0.	
10,000			0.	0.	.00½	
60,000		.0245		0.	.00½	
70,000		.0295		0.	.00½	
80,000		.0346		0.	.00½	
90,000		.0397		0.	.00½	
100,000		.0449		0.	.00½	
10,000			—.0002	0.	0.	
110,000		.0497		.00½	.02	
120,000		.0548		.01	.03	
130,000		.0600		.01	.03	
140,000		.0650		.01	.03	
150,000		.0703		.01	.04	
10,000			—.0006	0.	0.	
160,000		.0752		.01	.03	
170,000		.0805		.01	.04	
180,000		.0857		.01	.04	
190,000		.0909		.01	.04	
200,000		.0960		.01	.04	
10,000			—.0005	0.	0.	
210,000		.1011		.02	.04	
220,000		.1064		.02	.04	
230,000		.1114		.02	.04	
240,000		.1168		.02	.04	
250,000		.1220		.02	.05	
10,000			—.0003	0.	0.	
260,000		.1270		.03	.05	

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
270, 000		.1325		.03	.05	
280, 000		.1376		.03	.06	
290, 000		.1429		.03	.06	
300, 000		.1483		.03	.07	
10, 000			—.0003	0.	0.	
310, 000		.1538		.03	.07	
320, 000		1591		.03	.07	
330, 000		.1645		.03	.07	
340, 000		.1701		.03	.08	
350, 000		.1756		.03	.08	
10, 000			.0019	0.	0.	
360, 000		.1810		.03	.08	
370, 000		.1879		.03	.08	
380, 000		.1929		.03	.09	
390, 000		.1989		.03	.09	
400, 000		.2045		.03	.09	
10, 000			.0051	0.	0.	
410, 000		.2107		.03	.10	
420, 000		.2173		.03	.10	
430, 000		.2238		.03	.10	
440, 000		.2299		.03	.10	
450, 000		.2370		.04	.10	
10, 000			.0110	.02	0.	
460, 000		.2433		.04	.10	
470, 000		.2501		.04	.10	
480, 000		.2578		.04	.10	
490, 000		.2657		.04	.10	Scale starts off web of Channel A in five places, between middle and south end of column.
500, 000		.2735		.04	.10	
10, 000			.0209	.04	0.	
510, 000		.2822		.05	.11	
520, 000		.2910		.05	.11	
530. 000		.2999		.06	.12	
540, 000		.3090		.07	.12	
550, 000		.3238		.08	.12	
10, 000			.0447	.07	.10	
560, 000		.3409		.10	.12	
570, 000		.3635		.13	.12	
576, 700				.18	.05	
580, 000				.23	—.06	
582, 400	34, 279			.29	—.23	Ultimate strength.
575, 000				.23	—.33	
565, 000				.28	—.72	
540, 000				.32	—1.35	Test discontinued.

Failed by deflecting downward and sideways. The maximum deflection occurred two feet from the middle of the column towards the end where the scale was observed to start off first.

The continuous plate and Channel A were on the concave sides.

No. 338.—Set N.



(Tested with flat ends.)

Total length, 25′ 7⅞″.
Gauged length (along center of continuous Plate C), 260″.
Total weight (includes 8 eye-plates), 1,831 pounds.
Counter weight at middle, 915 pounds.

Sectional area.

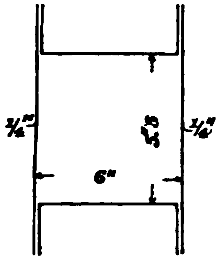
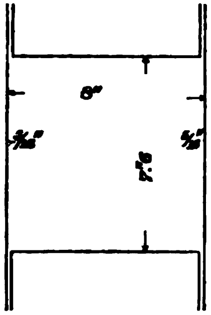
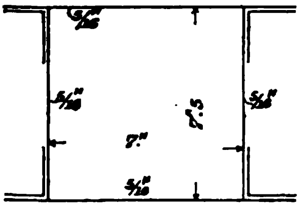
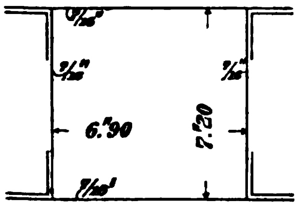
	Square inches.
Channel A, 25′ 8¼″; weight, 514 pounds; web, ″.32	6.00
Channel B, 25′ 8¼″; weight, 507 pounds; web, ″.3	5.92
Continuous plate, 25′ 8¼″; weight, 470 pounds	5.48
Total	17.40

Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,000		0.	0.	0.	0.	Initial load.
20,000		.0043		0.	0.	
30,000		.0093		0.	.01	
40,000		.0143		0.	.02	
50,000		.0193		—.01	.02	
10,000			0	0.	0.	
60,000		.0233		—.02	.03	
70,000		.0283		—.02	.03	
80,000		.0333		—.02	.03	
90,000		.0383		—.02	.03	
100,000		.0433		—.02	.03	
10,000			—.0001	0.	0.	
110,000		.0484		0.	.04	
120,000		.0534		0.	.04	
130,000		.0587		0.	.04	
140,000		.0637		0.	.04	
150,000		.0692		0.	.04	
10,000			—.0004	0.	0.	
160,000		.0740		0.	.05	
170,000		.0793		0.	.05	
180,000		.0843		—.01	.06	
190,000		.0893		—.01	.06	
200,000		.0948		—.02	.06	
10,000			—.0006	—.01	0.	
210,000		.0995		—.02	.07	
220,000		.1047		—.02	.07	
230,000		.1098		—.02	.07	
240,000		.1149		—.02	.07	
250,000		.1204		—.02	.07	
10,000			—.0008	0.	0.	
260,000		.1256		—.02	.07	

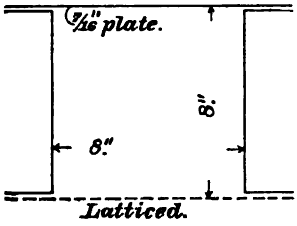
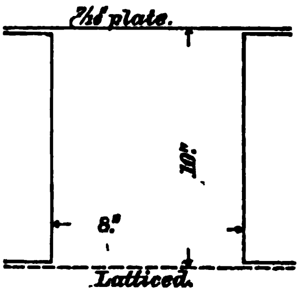
Applied loads.		In gauged length.		Deflections at middle.		Remarks.
Total.	Per square inch.	Compression.	Set.	Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
270,000	....	.1310	....	— .02	.07	
280,000	....	.1364	....	— .02	.08	
290,000	....	.1416	....	— .03	.08	
300,000	....	.1470	....	— .03	.08	
10,000	....	....	—.0003	0.	0.	
310,000	....	.1525	....	— .02	.08	
320,000	....	.1577	....	— .03	.08	
330,000	....	.1632	....	— .03	.08	
340,000	....	.1687	....	— .03	.09	
350,000	....	.1741	....	— .03	.09	
10,000	....	....	.0008	0.	0.	
360,000	....	.1798	....	— .03	.10	
370,000	....	.1853	....	— .03	.10	
380,000	....	.1908	....	— .03	.10	
390,000	....	.1966	....	— .03	.10	
400,000	....	.2021	....	— .03	.10	
10,000	....	....	.0028	— .01	0.	
410,000	....	.2084	....	— .03	.11	
420,000	....	.2144	....	— .03	.11	
430,000	....	.2208	....	— .03	.12	
440,000	....	.2275	....	— 03	.12	
450,000	....	.2342	....	— .03	.13	Snapping sounds.
10,000	....	....	.0078	— .02	.02	
460,000	....	.2409	....	— .03	.13	
470,000	....	.2475	....	— .03	.13	
480,000	....	.2547	....	— .03	.13	
490,000	....	.2622	....	— .03	.14	
500,000	....	.2703	....	— .04	.14	
10,000	....	....	.0170	— .04	.04	
510,000	....	.2815	....	— .04	.14	
520,000	....	.2803	....	— .04	.15	
530,000	....	.2995	....	— .05	.16	
540,000	....	.3105	....	— .06	.16	
550,000	....	.3203	....	— .07	.16	
10,000	....	....	.0378	— .08	.08	
560,000	....	.3330	....	— .09	.19	
570,000	....	.3535	....	— .11	.20	
580,000	33,333	.3898	....	— .30	.23	Ultimate strength.
570,000	....	....	....	— .50	.30	
540,000	....	....	....	—1.58	.48	Test discontinued.

Deflected diagonally, Channel-bar B and the latticed side being on the concave sides.

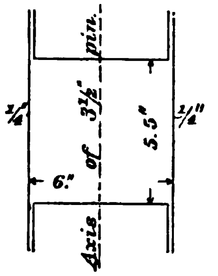
TABULATION OF EXPERIMENTS ON WROUGHT-IRON COLUMNS WITH FLAT ENDS.

No. of test.	Style of column.	Total length.		Sectional area.	Ultimate strength.		Manner of failure.
					Total.	Per sq. inch.	
		'	"	Sq. in.	Pounds.	Pounds.	
377	**Set B.** 	10	7.90	12.08	383,200	31,722	Buckling plate D between the riveting.
378		10	7.90	11.11	372,900	33,564	Buckling plates.
379	**Set E.** 	13	11.80	17.01	594,500	34,950	Buckling plates between the riveting.
380		13	11.80	17.80	638,600	35,595	Triple flexure.
346	**Set F.** 	13	11.9	15.74	517,000	32,846	Buckling plates.
347		13	11.65	15.84	555,200	35,050	Do.
342		20	7⅝	15.68	517,500	33,003	Deflecting upward.
344		20	7.80	15.56	536,900	34,505	Buckling plates.
348	**Set G.** 	13	11¾	21.02	708,000	33,682	Bucking plates.
349		13	11¾	21.46	709.500	33,061	Triple flexure.
341		20	7.6	21.20	700,000	33,019	Deflecting upward.
343		20	7⅝	21.49	729,450	33,948	Deflecting downward.

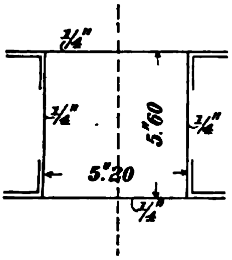
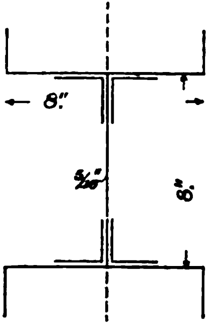
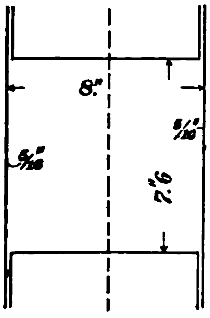
Tabulation of experiments on wrought-iron columns with flat ends—Continued.

No. of test.	Style of column.	Total length.		Sectional area.	Ultimate strength.		Manner of failure.
					Total.	Per sq. inch.	
		'	"	*Sq. in.*	*Pounds.*	*Pounds.*	
339	*Set K.*  	20	7.94	12.64	412,900	32,666	Deflecting upward; latticing on the concave side.
340		20	7.94	12.74	431,400	33,862	Do.
337	*Set N.*  	25	7⅜	16.99	582,400	34,279	Deflecting downward and sideways; the continuous plate and Channel A were on the concave sides.
338		25	7⅞	17.40	580,000	33,333	Deflecting diagonally; Channel B and latticing being on the concave sides.

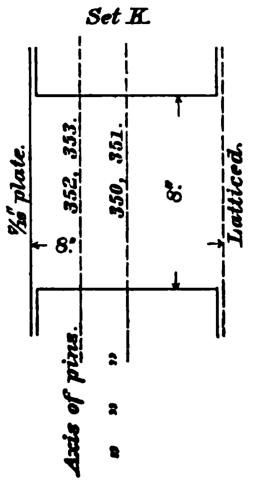
TABULATION OF EXPERIMENTS ON WROUGHT-IRON COLUMNS WITH 3½" PIN ENDS.

No. of test.	Style of column.	Length, center to center of pins.		Sectional area.	Ultimate strength.		Manner of failure.
					Total.	Per square inch.	
		'	"	*Sq. in.*	*Pounds.*	*Pounds.*	
368	*Set B.*  	15	0.1	11.42	379,200	33,205	Horizontal deflection, perpendicular to the plane of the pins.
367		15	0	11.42	369,200	32,329	Horizontal deflection.
356		20	0	11.42	342,000	29,947	Do.
357		20	0	11.31	330.100	29,186	Do.

Tabulation of experiments on wrought-iron columns with 3½″ pin ends—Continued.

No. of test.	Style of column.	Length, center to center of pins.	Sectional area.	Ultimate strength.		Manner of failure.
				Total.	Per square inch.	
		′ ″	*Sq. in.*	*Pounds.*	*Pounds.*	
371	*Set C.*  	9 11.9	9.14	286,100	31,302	Buckling the plates between the rivets.
372		10 0	10.07	319,200	31,698	Do.
370		15 0	9.21	291,500	31,650	Horizontal deflection and buckling between the rivets.
369		15 0	9.44	290,000	30,720	Do.
354		20 0	9.24	267,500	28,950	Triple flexure.
355		20 0	9.36	279,700	29,879	Horizontal deflection.
360	*Set D.*  	13 4½	15.34	475,000	30,965	Deflecting upward, in the plane of the 3½″ pins.
361		13 4	15.40	485,000	31,494	Horizontal deflection, perpendicular to the plane of the 3½″ pins.
358	*Set E.*  	20 0	17.77	570,000	32,077	Horizontal deflection, perpendicular to the plane of the pins.
359		20 0	17.22	555,400	32,253	Do.

Tabulation of experiments on wrought-iron columns with 3½" pin ends—Continued.

No. of test.	Style of column.	Length, center to center of pins.		Sectional area.	Ultimate strength.		Manner of failure.
					Total.	Per square inch.	
		'	"	*Sq. in.*	*Pounds.*	*Pounds.*	
350	 Set K. 5/16" plate. 352, 353. 350, 351. 8" 8" Latticed. Axis of pins. " " " "	20	0¼	12.48	202,700	16,242	Horizontal deflection, concave on latticed side.
351		20	0	10.84	208,200	19,207	Horizontal deflection, concaved on latticed side.
352		20	0¼	12.65	350,000	37,668	Horizontal deflection, concave on latticed side.
353		20	0¼	12.76	390,400	30,596	Horizontal deflection, perpendicular to the plane of the pins; convex on latticed side.

2.—COMPRESSION TESTS OF BRICK PIERS, TOGETHER WITH TESTS OF SINGLE BRICKS AND MORTARS USED IN THEIR CONSTRUCTION.

REMARKS ON TESTS OF THE SINGLE BRICKS.

Three kinds of bricks were employed in the construction of the piers.

The common and face bricks, both hard burnt, were from the yard of M. W. Sands, North Cambridge, Mass.

The bricks from the Bay State Brick Company, Boston and Cambridge, Mass., were medium burnt.

The latter kind had been used in a wall and the arches of a floor previous to being built into piers; none, however, appeared to have been injured.

The bricks were all tested between flat steel compression platforms, the compressed surfaces having been ground approximately flat with loose emery on a face-plate.

To improve the bearings and effect a better distribution of the load, thin pieces of brass packing were placed between the corners or edges of the bricks and the steel platforms, when there was sufficient opening.

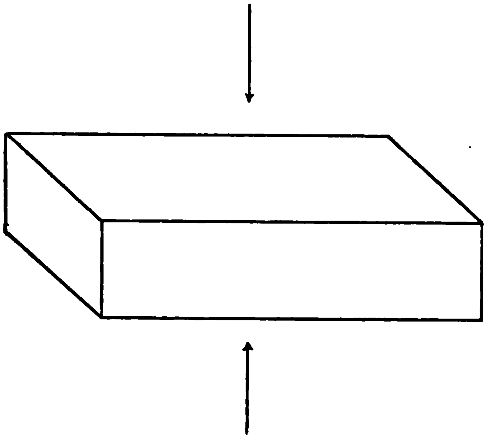
The average crushing strength of three bricks of a kind was used as a basis in comparing the efficiency of the different piers.

The strength of single bricks tested in this manner is largely in excess of the crushing strength of any pier.

When placed between rigid platforms with good bearings, a brick occupies a more favorable position for strength than between other bricks or cushions of less strength, the rigidity of the platforms contributing strength by preventing spreading in a direction at right angles to the line of pressure, due to the friction between the surfaces in contact.

Failure occurs in detail, the corners and along the edges first flaking off; a process which continues till the maximum load is reached, when disintegration becomes general and the sustaining power rapidly falls.

COMPRESSION OF SINGLE BRICKS.



FACE BRICKS.

Number of test.	Dimensions.			Compressed area.	Ultimate strength.		Remarks.
	Length.	Width.	Thickness.		Total.	Per square inch.	
	Inches.	*Inches.*	*Inches.*	*Sq. in.*	*Pounds.*	*Pounds.*	
4409	7.75	3.70	2.10	28.68	317,100	11,056	Brass packing used under corners to secure an even bearing.
4410	7.75	3.76	2.07	29.14	407,500	13,984	Packed under one corner.
4411	7.52	3.57	2.05	26.85	449,300	16,734	Packed along two edges.

Mean crushing strength, 13,925 pounds per square inch.

No. 4409.

Began to flake near one end under 174,000 pounds.
Failed gradually under the maximum load.

No. 4410.

Snapping sound at 104,000 pounds, but no cracks in sight.
At 175,000 pounds, flaked off at corner.
At 234,000 pounds, one end flaked off.

No. 4411.

At 110,000 pounds, flaked off at middle of one face.
At 237,000 pounds, continued crushing along one face.

COMMON BRICKS.

Number of test.	Dimensions.			Compressed area.	Ultimate strength.		Remarks.
	Length.	Width.	Thickness.		Total.	Per square inch.	
	Inches.	*Inches.*	*Inches.*	*Sq. in.*	*Pounds.*	*Pounds.*	
4412	8.12	3.50	2.07	28.42	562,300	19,785	Packed under two corners.
4413	7.90	3.56	2.15	28.12	628,500	22,351	Packed under three corners.
4414	8.10	3.62	2.12	29.32	381,000	12,995	Packed under two corners.

Mean crushing strength, 18,337 pounds per square inch.

No. 4412.

Cracking sounds at 348,000 pounds pressure, but no cracks in sight.

At 445,000 pounds first cracks appear, flaking off along one side. Fractured suddenly after passing the maximum load.

No. 4413.

At 312,000 pounds, cracked at corner.

At 405,000 pounds, flaked off along edges. Gradual failure after passing maximum load, reducing pressure to about 580,000 pounds, when sudden crushing occurred.

No. 4414.

At 95,000 pounds, flaked off at end near corner. Frequent flaking of specimens above load of 150,000 pounds.

Bay State Bricks (old).

Number of test.	Dimensions.			Compressed area.	Ultimate strength.		Remarks.
	Length.	Width.	Thickness.		Total.	Per square inch.	
	Inches.	*Inches.*	*Inches.*	*Sq. in.*	*Pounds.*	*Pounds.*	
4415	7.90	3.57	2.06	28.20	313,600	11,120	One corner packed; otherwise took an even bearing.
4416	7.78	3.70	2.02	28.79	365,900	12,709	Two corners packed.
4417	7.70	3.50	2.11	26.95	280,000	10,390	Took even bearings without packing.

Mean crushing strength, 11,406 pounds per square inch.

No. 4415.

Began to flake off at end under 145,000 pounds pressure. Opened cracks and flaked off at edges generally after passing 250,000 pounds.

No. 4416.

Began to flake at end near corner under 215,000 pounds pressure.

No. 4417.

Began to crack along one edge at 196,000 pounds.

At 258,000 pounds decided yielding occurred, the pressure remaining stationary about one minute. The brick then gave a higher resistance, the load increasing to 280,000 pounds, its maximum, after which gradual failure occurred.

REMARKS ON TESTS OF THE MORTAR.

Three cubes of each kind of mortar were made at the time and allowed to season with the piers, and at the age of 14½ months they were tested.

The age of the plaster of paris cube was 4 months.

The cubes were tested between flat steel platforms, after the manner of the tests of single bricks. Micrometer measurements from face to face of the steel platforms showed the compression of the cubes under stress, and are tabulated in detail.

Diagrams illustrating the compressibility follow the tables, selecting the most rigid cube of each kind of mortar as best indicating the quality of that composition.

The marked difference in crushing strength of the same kinds of mortar is accompanied by a corresponding difference in their relative compressibility, the strongest cement being also the stiffest.

When lime mortar is added to cement, in the proportions here employed, its effect on the mortar is found comparatively more serious with the Portland cement than with Rosendale cement, weakening each to such an extent that practically there is little difference in the resulting mortar, either as regards strength or compressibility, whether Portland or Rosendale cement is used.

Plaster of paris has been found a convenient and useful material for facing the ends of brick, stone, and mortar specimens for the purpose of securing even bearings when tested, its crushing strength and stiffness giving it a high rank among cements and mortars.

CRUSHING STRENGTH OF 6" CUBES REPRESENTING MORTAR EMPLOYED IN THE CONSTRUCTION OF BRICK PIERS.

No. of test.	Composition.	Actual dimensions.			Sectional area.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.	Remarks.
		Length.	Compressed surface.				Total.	Per square inch.		
		Inches.	*Inches.*	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
3a	1 part lime, 3 parts sand	6.00	5.90	5.80	34.2	....	4,620	135	111.75	
3b	......do	6.02	5.82	5.95	34.6	....	4,110	119	110.81	Compressed faces convex.
3c	......do	6.00	5.90	5.87	34.6	....	4,100	118	105.88	
4a	1 part Portland cement, 2 parts sand	6.00	5.96	6.00	35.8	....	20,050	560	116.25	
4b	......do	6.11	6.00	5.97	35.8	....	24,900	696	119.50	
4c	......do	6.02	5.95	6.02	35.8	11,500	13,700	383	114.94	
5a	1 part Rosendale cement, 2 parts sand	6.04	5.95	6.10	36.3	....	5,680	156	110.50	
5b	......do	6.08	6.05	6.05	36.6	....	6,820	186	108.88	
5c	......do	6.22	6.00	6.00	36.0	4,500	5,140	143	106.50	
6a	Clear Portland cement	6.05	6.00	6.02	36.1	....	96,500	2,673	125.75	
6b	......do	6.02	6.00	6.03	36.1	95,000	128,100	3,548	129.31	
6c	......do	6.10	5.92	5.97	35.3	....	149,200	4,227	134.75	
7a	Clear Rosendale cement	6.06	5.98	6.00	35.9	11,000	15,100	421	94.38	
7b	......do	6.10	6.00	6.05	36.4	19,000	22,400	615	98.94	
7c	......do	6.10	6.14	6.05	37.1	19,200	19,500	526	97.00	
8a	1 part Portland cement, 2 parts lime mortar (lime mortar, 1 part lime, 3 parts sand).	6.03	6.00	6.00	36.0	....	7,350	204	108.63	
8b	......do	6.00	6.00	6.00	36.0	....	7,110	198	110.19	
8c	......do	6.10	6.05	6.14	37.1	....	6,480	175	103.44	
9a	1 part Rosendale cement, 2 parts lime mortar (lime mortar, 1 part lime, 3 parts sand).	6.00	5.93	5.95	35.3	....	6,850	194	105.19	
9b	......do	6.00	5.92	5.92	35.0	....	6,760	193	106.06	
9c	......do	6.00	5.92	5.98	35.4	....	5,740	162	105.38	
	Plaster of paris	6.04	6.02	6.01	36.2	....	71,700	1,981	74.37	Bearings convex ".00⅛; snapping sounds at 39,500 pounds.

COMPRESSION OF 6" MORTAR CUBES, SHOWING THE COMPRESSIBILITY OF THE CUBES UNDER STRESS.

No. of test.	Composition.	Compression under loads in pounds of—																	
		500.	1,000.	2,000.	3,000.	4,000.	5,000.	6,000.	7,000.	8,000.	9,000.	10,000.	12,000.	14,000.	16,000.	18,000	20,000.	25,000.	30,000.
		Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
3*a*	1 part lime, 3 parts sand	0	.0014	.0056	.0124	.0194	......	......	......	......	......	......	......	......	......	......	......	......	......
3*b*	......do	0	.0005	.0160	.0310	......	......	......	......	......	......	......	......	......	......	......	......	......	......
3*c*	......do	0	.0020	.0080	.0146	.0450	......	......	......	......	......	......	......	......	......	......	......	......	......
4*a*	1 part Portland cement, 2 parts sand	0	.0010	.0025	.0038	.0050	.0060	.0070	.0080	.0085	.0095	.0108	.0120	.0148	.0170	.0215	.0310	......	......
4*b*	......do	0	.0000	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
4*c*	......do	0	.0010	.0022	.0030	.0050	.0065	.0080	.0098	.0120	.0140	.0170	.0250	......	......	......	......	......	......
5*a*	1 part Rosendale cement, 2 parts sand	0	.0020	.0040	.0060	.0090	.0160	......	......	......	......	......	......	......	......	......	......	......	......
5*b*	......do	0	.0015	.0040	.0062	.0090	.0130	.0175	......	......	......	......	......	......	......	......	......	......	......
5*c*	......do	0	.0040	.0100	.0170	.0235	.0395	......	......	......	......	......	......	......	......	......	......	......	......
6*a*	Clear Portland cement	0	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
6*b*	......do	0	0.	.0010	.0020	.0030	.0035	.0040	.0045	.0048	.0050	.0052	.0053	.0054	.0054	.0054	.0054	.0054	.0058
6*c*	......do	0	.0008	.0012	.0018	.0023	.0030	.0035	.0040	.0045	.0050	.0052	.0060	.0065	.0072	.0078	.0082	.0098	.0108
7*a*	Clear Rosendale cement	0	.0010	.0018	.0025	.0035	.0040	.0045	.0045	.0050	.0060	.0070	.0120	.0250	......	......	......	......	......
7*b*	......do	0	.0010	.0020	.0035	.0050	.0065	.0078	.0090	.0100	.0108	.0120	.0140	.0160	.0185	.0220	.0260	......	......
7*c*	......do	0	.0018	.0055	.0090	.0110	.0135	.0155	.0180	.0200	.0220	.0245	.0290	.0335	.0395	.0480	......	......	......
8*a*	1 part Portland cement, 2 parts lime mortar (lime mortar, 1 part lime, 3 parts sand)	0	.0005	.0020	.0035	.0050	.0070	.0090	.0130	......	......	......	......	......	......	......	......	......	......
8*b*	......do	0	.0015	.0048	.0075	.0092	.0120	.0160	.0230	......	......	......	......	......	......	......	......	......	......
8*c*	......do	0	.0030	.0105	.0180	.0270	.0370	.0480	......	......	......	......	......	......	......	......	......	......	......
9*a*	1 part Rosendale cement, 2 parts lime mortar (lime mortar, 1 part lime, 3 parts sand)	0	.0010	.0045	.0090	.0150	.0220	.0290	......	......	......	......	......	......	......	......	......	......	......
9*b*	......do	0	.0005	.0018	.0030	.0045	.0075	.0130	......	......	......	......	......	......	......	......	......	......	......
9*c*	......do	0	.0005	.0020	.0045	.0070	.0120	......	......	......	......	......	......	......	......	......	......	......	......
....	Plaster of paris	0	.0002	.0008	.0018	.0024	.0030	.0038	.0040	.0048	.0052	.0058	.0067	.0078	.0082	.0092	.0102	.0120	.0138

No. of test.	Composition.	Compression under loads in pounds of—																
		40,000.	50,000.	60,000.	70,000.	80,000.	85,000.	90,000.	95,000.	100,000.	105,000.	110,000.	115,000.	120,000.	125,000.	130,000.	135,000.	140,000.
		Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
4*a*	1 part Portland cement, 2 parts sand	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
6*b*	Clear Portland cement	.0066	.0078	.0090	.0102	.0120	.0135	.0148	.0160	.0170	.0185	.0200	.0215	......	......	......	......	......
6*c*	......do	.0125	.0145	.0160	.0180	.0200	.0208	.0215	.0225	.0235	.0250	.0265	.0278	.0290	.0305	.0320	.0335	.0360
7*b*	Clear Rosendale cement	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
....	Plaster of paris	.0175	.0220	.0281	.0400	......	......	......	......	......	......	......	......	......	......	......	......	......

REMARKS ON THE TESTS OF BRICK PIERS.

This series embraces the test of thirty-three piers, built of two kinds of common bricks and one kind of face brick, which were laid in mortars of different composition. The cross-section dimensions range from 8″ × 8″ to 16″ × 16″, and the heights from 16 inches to 10 feet.

The bricks were laid on bed, and joints broken every course, with the exception of two 12″ × 12″ piers, one of which had joints broken every sixth course, and one had the bricks laid on edge.

They were built in the month of May, 1882, and seasoned in a cool, dry building. Their ages when tested ranged from 14 to 24 months.

During seasoning it became necessary to move the piers to another building, at which time some of them were broken. The fractured sections were set up and joints remade with plaster of paris or lime mortar immediately before testing.

They were transported to the testing machine without injury, in a fixture consisting of two cast-iron plates, which were set on the ends of the pier in plaster of paris. Wrought-iron tie-rods, provided with turnbuckles, connected the cast-iron plates. By tightening the tie-rods the inclosed pier is placed in a state of compression, thus increasing its transverse strength sufficient to enable it to be transported and adjusted in the horizontal position in which it was tested. When the initial load had been applied the tension on the tie-rods was released.

Compression measurements were taken within the gauged length—a distance laid off along the center line of the pier, and middle part of its height. Contact of the pier with the beam of the micrometer was made through blocks carrying conical spur points clamped to the bricks.

When the gauged length and height of the pier are the same, the compression measurements were taken from face to face of the compression platforms.

Loads were gradually applied in regular increments, measuring the compression as the loads advanced, and returning at intervals to the initial load to determine the permanent set; continuing in this manner till the maximum load was nearly reached, when the micrometer was removed for safety, and the pier covered with canvas; then increasing the pressure till the ultimate resistance was determined.

One pier was tested with repeated loadings, and the loads allowed to remain acting for periods of five minutes each, measuring the compression of the pier when the loads were first applied and at the expiration of that time. The sets were determined in the same manner.

Cracks made their appearance at the surfaces of the piers and were gradually enlarged before the maximum loads were reached. Final failure occurred by the partial crushing of some of the bricks, and by the enlargement of these cracks, which took a longitudinal direction and occurred in the bricks of one course opposite the end joints of the bricks in the adjacent courses. This manner of failure was common to all the piers.

In examining the results of the cement and mortar tests, superior strength is found in the Portland cement; likewise the piers laid in Portland cement gave the highest resistance, while piers of the same kind of bricks but laid in weaker mortar showed lower results, from which it appears that the quality of the mortar employed is a very important function in the strength of brick-work.

A material tested between cushions weaker than itself suffers by the disintegration of those cushions.

The mortar acting as a cushion to distribute the load of compression, the nearer the physical properties of the mortar approach those of the bricks the more strength will be developed in the pier.

The influence of the mortar on the behavior of the piers is further shown by the amount of their compression under stress, as given in the details of the tests and illustrated by diagrams plotted from the compression measurements there recorded.

The yielding of the piers is confined largely to mortar in the joints. Therefore in their behavior they resemble the cubes which represent the kinds of mortar employed.

The early compressions recorded during some of the tests show an apparent rigidity not originally possessed by the pier, but which resulted from the load on the tie-rods during transportation of the piers exceeding the initial load of the test. This is most conspicuous with piers laid in the weaker class of mortars.

The second application of a given load usually caused an increase in the total amount of compression, and as the higher loads were reached the difference of the two readings became greater. The quality of the mortar in this case was a controlling element.

It is believed that repeated loads would eventually reduce the ultimate strength of a pier by first destroying the mortar, after which the bricks would fail in detail, on account of the unequal distribution of load which would ensue.

The higher result obtained with pier No. 289, which was subjected to repeated loading, is regarded as exceptional.

Pier No. 291, with joints broken every sixth course, was 13.6 per cent. stronger than the average of piers Nos. 288 and 289, laid in the same kind of mortar with joints broken every course.

Laying the bricks on edge also appears to have a tendency to increase the strength of the pier.

These examples are from piers laid in lime mortar, the weakness of which causes the bricks to fracture under transverse stress. The piers are strengthened in this direction by laying the bricks on edge, or laying several courses before breaking joints.

Comparing solid and hollow piers laid in the same kind of mortar, the strength is substantially the same for the short face brick piers (Nos. 283 and 284). In common brick there is a difference in favor of the solid pier (Nos. 281 and 282). In each case, however, with piers 10 feet high, the strength of the hollow exceeds that of the solid pier, not only in pounds per square inch of actual compressed surface, but the gross load sustained is greater for the hollow than the solid pier.

The relative strength of the piers 10 feet high is as follows, calling the strength of the solid piers 100:

No. of test.	Nominal dimensions.		Kind of brick.	Relative strength.			
				Gross load.		Per square inch.	
	Cross-section.	Height.		Solid pier.	Hollow pier.	Solid pier.	Hollow pier.
	Inches.	*Feet.*				*Pounds.*	*Pounds.*
332, 334	12 by 12	10	Face......	100	105	100	120
331, 330	12 by 12	10	Common..	100	120	100	142

Piers have been built and are now seasoning, which are intended to show the absolute and relative strength of solid and hollow piers for intermediate lengths, not covered by this series of experiments.

Arranging the single bricks and such piers as are directly comparable in the order of their strength, we have—

Strength of single bricks.

	Pounds per square inch.
Common bricks	18,337
Face bricks	13,925
Bay State bricks	11,400

[12″ × 12″ piers, 24″ high, laid in lime mortar.]

No. of test.	Kind of brick.	Ultimate strength per square inch.	Efficiency.
		Pounds.	*Per cent.*
281	Common	2,150	11.7
283	Face	1,940	13.9
285	Bay State	1,370	12.0

[12″ × 12″ piers, 10′ high, laid in lime mortar.]

No. of test.	Kind of brick.	Ultimate strength per square inch.	Efficiency.
332	Face	1,511	10.9
331	Common	1,118	6.1
327	Bay State	924	8.1

[12″ × 12″ piers, 10′ high, laid in mortar composed of Portland cement, 1 part; sand, 2 parts.]

No. of test.	Kind of brick.	Ultimate strength per square inch.	Efficiency.
326	Face	2,253	16.2
329	Common	2,003	10.9

From the above comparisons it is seen that the highest results, when tested singly, are obtained with the common bricks; and that the same order of strength prevails in the lime mortar piers 24″ high, whereas in the piers 10′ high, whether laid in lime or cement mortar, the difference in strength is in favor of face brick; a result attributed to the evenness of the bed surfaces of the face bricks over the common bricks, by which a better distribution of the loads of compression is obtained.

In order to judge of the quality of brick work with reference to the kind of mortar employed, the following table is given, taken from the results of Bay State bricks in 12″×12″ piers, 6′ high.

No. of test.	Composition of mortar.	Efficiency of pier.
		Per cent.
288	1 lime, 3 sand	9.9
289	1 lime, 3 sand	10.6
301	2 lime mortar (1 lime, 3 sand), 1 Rosendale cement	14.4
293	1 Rosendale cement, 2 sand	17.3
300	2 lime mortar (1 lime, 3 sand), 1 Portland cement	12.4
294	1 Portland cement, 2 sand	15.7
290	Clear Portland cement	20.8

The difference in the compressibility exhibited by these piers, due to the quality of the mortar, shows that it is essential, in order for piers to work together in harmony, that they should be laid all in the same kind of mortar, with joints practically of the same thickness.

TABULATION OF CRUSHING STRENGTH OF BRICK PIERS.

No. of test.	Nominal dimensions.				Composition of mortar.	Weight per cubic foot.	Actual dimensions.				Sectional area.	Ultimate strength.			
	Height.		Cross-section.				Height.		Cross-section.			Total.	Per square inch.	Per square foot.	Per cent. of single brick.
	Ft.	*In.*	*Inches.*	*Inches.*		*Lbs.*	*Ft.*	*In.*	*Inches.*	*Inches.*	*Sq. in.*	*Pounds.*	*Lbs.*	*Tons.*	
					BUILT OF FACE BRICKS.										
11	1	4	8	8	1 lime, 3 sand	137.4	1	4.13	7.55	7.55	57.00	143,600	2,520	181.4	18.1
320	6	8	8	8	1 lime, 3 sand	133.5	6	8.00	7.60	7.60	57.76	108,400	1,877	135.1	13.5
12	1	4	8	8	1 Portland cement, 2 sand	136.8	1	4.24	7.60	7.60	57.76	218,100	3,776	271.8	27.1
321	6	8	8	8	1 Portland cement, 2 sand	133.5	6	8.00	7.60	7.60	57.76	129,900	2,249	161.9	16.2
283	2	0	12	12	1 lime, 3 sand	....	1	11.05	11.50	11.50	132.25	257,100	1,940	139.7	13.9
284*	2	0	12	12	1 lime, 3 sand	....	1	11.04	11.50	11.50	113.76	226,100	1,990	143.3	14.3
332	10	0	12	12	1 lime, 3 sand	131.7	9	11.90	11.50	11.50	132.25	199,800	1,511	108.8	10.9
334†	10	0	12	12	1 lime, 3 sand	125.0	9	11.13	11.50	11.50	115.44	208,600	1,807	130.1	13.0
286	2	0	12	12	1 Portland cement, 2 sand	....	1	11.50	11.50	11.50	132.25	486,000	3,670	264.2	26.4
326	10	0	12	12	1 Portland cement, 2 sand	132.2	9	11.30	11.50	11.50	132.25	298,000	2,253	162.2	16.2
					BUILT OF COMMON BRICKS.										
10	1	4	8	8	1 lime, 3 sand	135.6	1	4.48	7.8	7.8	60.80	148,800	2,440	175.6	13.3
12½	6	8	8	8	1 lime, 3 sand	133.6	6	8.05	7.9	7.9	62.40	96,100	1,540	110.8	8.4
281	2	0	12	12	1 lime, 3 sand	....	1	11.90	11.75	11.75	138.06	296,400	2,150	154.8	11.7
282‡	2	0	12	12	1 lime, 3 sand	....	2	0.30	11.75	11.90	119.58	244,600	2,050	147.6	11.2
331	9	9	12	12	1 lime, 3 sand	131.5	9	9.6	11.75	11.75	138.06	154,300	1,118	80.5	6.1
330§	10	0	12	12	1 lime, 3 sand	136.0	10	0.4	11.75	11.75	115.50	183,300	1,587	114.3	8.6
329	10	0	12	12	1 Portland cement, 2 sand	131.0	10	.0	11.75	11.75	138.06	276,600	2,003	144.2	10.9
287	2	8	16	16	1 Portland cement, 2 sand	....	2	7.85	16.00	16.00	256.00	696,000	2,720	195.8	14.8
328	10	0	16	16	1 Portland cement, 2 sand	....	10	1.00	16.00	16.00	256.00	483,100	1,887	135.8	10.3
					BUILT OF BAY STATE BRICKS.										
285	2	0	12	12	1 lime, 3 sand	....	2	0.10	12.10	12.10	146.41	201,000	1,370	98.6	12.0
288	6	0	12	12	1 lime, 3 sand	....	6	0.50	12.00	12.00	144.00	163,200	1,133	81.6	9.9
289	6	0	12	12	1 lime, 3 sand	119.7	6	1.00	12.00	12.00	144.00	174,300	1,210	87.1	10.6

* Has hollow center 4".25 × 4".25.

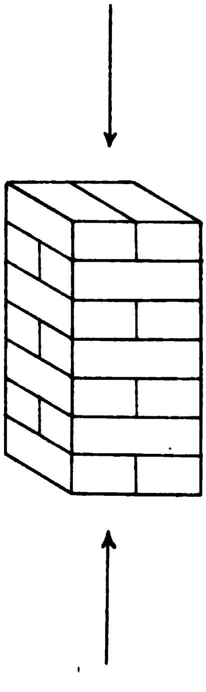
† Has hollow center 4".1 × 4".1.

‡ Has hollow center 4".5 × 4".5.

§ Has hollow center 4".75 × 4".75.

No. 11

8 inch Brick pier



S Ex 35 49 1

No. 11.

8″ brick pier.

[Built of seven courses of face brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Age when tested, fifteen months.]

Total weight of pier, 73 pounds.
Weight per cubic foot, 137.4 pounds.
Total height, 16⅛″.
Sectional area, 7″.55 × 7″.55 = 57.0 square inches.
Gauged length, 16⅛″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000		0.		
5,000		.0060		
10,000		.0115		
1,000			.0085	
15,000		.0175		
20,000		.0230		
1,000			.0160	
25,000		.0280		
30,000		.0330		
1,000			.0230	
35,000		.0390		
40,000		.0440		
1,000			.0820	
45,000		.0520		
50,000		.0560		
1,000			.0400	
55,000		.0645		
60,000		.0700		
65,000		.0770		
70,000		.0830		
75,000		.0890		
80,000		.0950		
85,000		.1000		Crack appeared in end course.
90,000		.1090		
95,000		.1210		Longitudinal cracks generally developed in alternate courses, opposite joints.
100,000		.1255		
105,000		.1290		
110,000		.1350		
115,000		.1450		
120,000		.1580		
125,000		.1660		
130,000		.1960		
135,000		.1790		
143,600	2,520			Ultimate strength.

No. 320.

8″ brick pier.

[Built of thirty-five courses of face brick, laid in lime mortar. Composition of mortar, one part lime three parts sand. Average thickness of joints, ⅜″. Age when tested, twenty-three months.]

Total weight of pier, 357 pounds.
Weight per cubic foot, 133.5 pounds.
Total height, 80″.
Sectional area, 7″.6×7″.6=57.76 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
7,500	....	.0020	....	
10,000	....	.0038	....	
5,000	....	....	.0005	
12,500	....	.0052	....	
15,000	....	.0083	....	
5,000	....	....	.0020	
17,500	....	.0135	....	
20,000	....	.0190	....	
5,000	....	....	.0088	
22,500	....	.0256	....	
25,000	....	.0318	....	
5,000	....	....	.0170	
27,500	....	.0390	....	
30,000	....	.0468	....	
5,000	....	....	.0270	
32,500	....	.0545	....	
35,000	....	.0610	....	
5,000	....	....	.0338	
37,500	....	.0685	....	
40,000	....	.0730	....	
5,000	....	....	.0470	
42,500	....	.0812	....	
45,000	....	.0855	....	
5,000	....	....	.0556	
47,500	....	.0932	....	
50,000	....	.0972	....	Cracks in five courses near the middle of the length of the pier.
5,000	....	....	.0645	
52,500	....	.1072	....	
55,000	....	.1115	....	
5,000	....	....	.0745	
57,500	....	.1208	....	
60,000	....	.1255	....	
5,000	....	....	.0845	Micrometer removed.
108,400	1,877	....	....	Ultimate strength.

Failed by opening longitudinal seams, and partially crushing bricks in thirteen courses near the middle of the pier.

When the micrometer was removed the pier was then covered with canvas. Frequent snapping sounds were heard after the load passed 75,000 pounds.

Occasionally the load would fall momentarily, when there was sudden yielding of the pier.

No. 12.

8″ *brick pier.*

[Built of seven courses of face brick, laid in cement mortar. Composition of mortar, one part Portland cement, two parts sand. Age when tested, fifteen months.]

Total weight of pier, 74 pounds.
Weight per cubic foot, 136.3 pounds.
Total height, 16″.24.
Sectional area, 7″.6×7″.6=57.76 square inches.
Gauged length, 16″.24.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0020	....	
10,000	....	.0035	....	
1,000	....	....	.0015	
15,000	....	.0055	....	
20,000	....	.0075	....	
1,000	....	....	.0030	
25,000	....	.0095	....	
30,000	....	.0115	....	
1,000	....	....	.0040	
35,000	....	.0140	....	
40,000	....	.0160	....	
1,000	....	....	.0058	
45,000	....	.0185	....	
50,000	....	.0210	....	
1,000	....	....	.0080	
55,000	....	.0242	....	
60,000	....	.0260	....	
65,000	....	.0288	....	
70,000	....	.0305	....	
75,000	....	.0325	....	
80,000	....	.0350	....	End brick shelled off the face, next compression platform.
85,000	....	.0375	....	
90,000	....	.0390	....	
95,000	....	.0410	....	
100,000	....	.0428	....	
1,000	....	....	.0210	
105,000	....	.0480	....	
110,000	....	.0495	....	
115,000	....	.0515	....	
120,000	....	.0535	....	
125,000	....	.0555	....	
130,000	....	.0578	....	
135,000	....	.0590	....	
140,000	....	.0610	....	
145,000	....	.0640	....	
150,000	....	.0660	....	
1,000	....	....	.0365	
155,000	....	.0710	....	
160,000	....	.0730	....	
165,000	....	.0750	....	
170,000	....	.0770	....	
175,000	....	.0790	....	
180,000	....	.0810	....	
185,000	....	.0830	....	
190,000	....	.0860	....	
195,000	....	.0890	....	
200,000	....	.0915	....	Cracks opened in second and fifth courses.
205,000	....	.0965	....	
210,000	....	.0990	....	
1,000	....	....	.0545	
210,000	....	.1140	....	
218,100	3,776	....	....	Ultimate strength.

No. 321.

8″ *brick pier.*

[Built of thirty-five courses of face brick, laid in cement mortar. Composition of mortar, one part Portland cement, two parts sand. Average thickness of joints, ½″. This pier was broken into three pieces in transportation to testing machine, separating between the fourth and fifth and between the twenty-third and twenty-fourth courses. Pier was set up without additional cement in the broken joints. Age when tested, twenty-three months.]

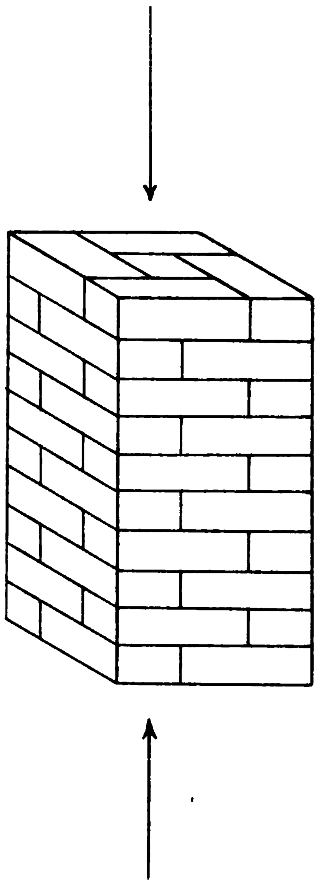
Total weight of pier, 357 pounds.
Weight per cubic foot, 133.5 pounds.
Total height, 80″.
Sectional area, 7″.6 × 7″.6 = 57.76 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
7, 500	....	.0008	....	
10, 000	....	.0018	....	
12, 500	....	.0028	....	
15, 000	....	.0040	....	
17, 500	....	.0050	....	
20, 000	....	.0062	....	
5, 000	....	....	.0012	
22, 500	....	.0078	....	
25, 000	....	.0090	....	
27, 500	....	.0105	....	
30, 000	....	.0118	....	
5, 000	....	....	.0028	
32, 500	....	.0130	....	
35, 000	....	.0140	....	
37, 500	....	.0152	....	
40, 000	....	.0168	....	
5, 000	....	....	.0040	
42, 500	....	.0185	....	
45, 000	....	.0199	....	
47, 500	....	.0215	....	
50, 000	....	.0228	....	
5, 000	....	....	.0068	
52, 500	....	.0250	....	
55, 000	....	.0262	....	
57, 500	....	.0275	....	
60, 000	....	.0290	....	
5, 000	....	....	.0082	
62, 500	....	.0310	....	
65, 000	....	.0325	....	
67, 500	....	.0338	....	
70, 000	....	.0358	....	
5, 000	....	....	.0108	
72, 500	....	.0378	....	
75, 000	....	.0390	....	
77, 500	....	.0405	....	
80, 000	....	.0420	....	
5, 000	....	....	.0125	
82, 500	....	.0440	....	
85, 000	....	.0458	....	Cracks opend in second, third, and fourth courses.
87, 500	....	.0470	....	
90, 000	....	.0488	....	
5, 000	....	....	.0150	
92, 500	....	.0528	....	
95, 000	....	.0550	....	Cracks developed in courses 1 to 7, accompanied by slight explosive sounds.
5, 000	....	....	.0185	Micrometer now removed, and pier covered with canvas.
129, 900	2, 249	....	....	Ultimate strength.

Pier failed by partially crushing bricks in lower courses, and opening longitudinal seams half the length of the pier.

No. 283

12 inch Brick pier.



No. 283.

12″ *brick pier.*

[Built of ten courses of face brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Age when tested, eighteen and one-half months.]

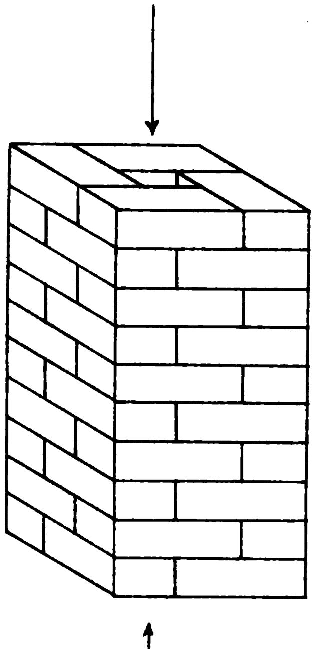
Total height, 23″.05.
Sectional area, 11″.50 x 11″.50 = 132.25 square inches.
Gauged length, 23″.05.

Applied loads.		Compression.	Set.	Remarks.
Total	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0022	....	
15,000	....	.0050	....	
20,000	....	.0075	....	
25,000	....	.0102	....	
5,000	....	....	.0062	
25,000	....	.0102	....	
30,000	....	.0130	....	
35,000	....	.0155	....	
40,000	....	.0182	....	
45,000	....	.0210	....	
50,000	....	.0235	....	
5,000	....	....	.0144	
50,000	....	.0252	....	
55,000	....	.0270	....	
60,000	....	.0292	....	
65,000	....	.0320	....	
70,000	....	.0350	....	
75,000	....	.0372	....	
5,000	....	....	.0240	
75,000	....	.0396	....	
80,000	....	.0410	....	
85,000	....	.0430	....	
90,000	....	.0470	....	
95,000	....	.0500	....	
100,000	....	.0550	....	
5,000	....	....	.0360	
100,000	....	.0582	....	
110,000	....	.0660	....	Snapping sounds.
120,000	....	.0745	....	
130,000	....	.0825	....	
140,000	....	.0965	....	Longitudinal cracks in sight.
150,000	....	.1050	....	
160,000	....	.1250	....	
170,000	....	.1370	....	
180,000	....	.1440	....	
190,000	....	.1540	....	
200,000	....	.1675	....	
257,100	1,940	....	....	Ultimate strength.

No. 284

12 inch Brick pier.

Hollow centre.



S Ex 35 49 1

No. 284.

12" brick pier, hollow center.

[Built of ten courses of face brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Age when tested, eighteen and a half months.]

Total height, 23".04.
Dimensions of cross-section, 11".5 x 11".5=132.25 square inches.
Dimensions of hollow center, 4".25 x 4".35=18.49 square inches.
Sectional area, 113.76 square inches.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0080	....	
15,000	....	.0145	....	
20,000	....	.0185	....	
25,000	....	.0230	....	
5,000	....	....	.0145	
25,000	....	.0240	....	
30,000	....	.0272	....	
35,000	....	.0310	....	
40,000	....	.0350	....	
45,000	....	.0390	....	
50,000	....	.0428	....	
5,000	....	....	.0285	
50,000	....	.0450	....	
60,000	....	.0520	....	
65,000	....	.0560	....	
70,000	....	.0615	....	
75,000	....	.0650	....	
5,000	....	....	.0435	
75,000	....	.0685	....	
80,000	....	.0720	....	Snapping sounds. No cracks in sight.
85,000	....	.0770	....	
90,000	....	.0815	....	Brick in end course crushes.
95,000	....	.0870	....	
100,000	....	.0930	....	
5,000	....	....	.0640	
100,000	....	.0975	....	
110,000	....	.1050	....	
120,000	....	.1140	....	
130,000	....	.1255	....	
140,000	....	.1335	....	
150,000	....	.1450	....	
160,000	....	.1540	....	
170,000	....	.1650	....	
180,000	....	.1760	....	
190,000	....	.1850	....	
200,000	....	.2010	....	
226,100	1,990	....	....	Ultimate strength.

No. 286.

12″ *brick pier*.

[Built of ten courses of face brick, laid in cement mortar. Composition of mortar, one part Portland cement, two parts sand. Age when tested, eighteen and one-half months.]

Total height, 23″.50.
Sectional area, 11″.50 × 11″.50 = 132.25 square inches.
Gauged length, 23″.50.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0010		
20,000		.0030		
30,000		.0045		
40,000		.0062		
50,000		.0085		
5,000			.0030	
50,000		.0090		
60,000		.0115		
70,000		.0150		
80,000		.0190		
90,000		.0220		
100,000		.0260		
5,000			.0140	
100,000		.0280		
110,000		.0295		
120,000		.0320		
130,000		.0350		
140,000		.0375		
150,000		.0405		
5,000			.0210	
150,000		.0430		
160,000		.0445		
170,000		.0460		
180,000		.0480		
190,000		.0500		
200,000		.0520		Crack in third course.
5,000			.0250	
200,000		.0550		
10,000				Load released, but no compression reading taken.
210,000		.0590		
220,000		.0602		
230,000		.0612		
240,000		.0630		
250,000		.0640		
5,000			.0310	
250,000		.0660		
260,000		.0675		
270,000		.0692		
280,000		.0710		
290,000		.0730		
300,000		.0750		
5,000			.0360	
300,000		.0762		
310,000		.0785		
320,000		.0800		Longitudinal cracks from end to end.
330,000		.0820		
340,000		.0870		Rested under this load 5 minutes.
350,000		.0885		
360,000		.0905		
370,000		.0925		
380,000		.0942		
390,000		.0963		
400,000		.0990		
410,000		.1020		
420,000		.1050		
430,000		.1075		
440,000		.1102		
450,000		.1152		
460,000		.1220		
470,000		.1310		
486,000	3,670			Ultimate strength.

No. 326.

12'' brick pier.

[Built of fifty-one courses of face brick, laid in cement mortar. Composition of mortar, one part Portland cement, two parts sand. Average thickness of joints, $\frac{3}{16}$''. Age when tested, twenty-three and a half months.]

Total weight of pier, 1,207 pounds.
Weight per cubic foot, 132.2 pounds.
Total height, 119''.30.
Sectional area, 11''.5 × 11''.5=132.25 square inches.
Gauged length, 100''.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0029	....	
30,000	....	.0059	....	
40,000	....	.0092	....	
50,000	....	.0126	....	
10,000	....	....	—.0004	
60,000	....	.0154	....	
70,000	....	.0191	....	
80,000	....	.0225	....	
90,000	....	.0261	....	
100,000	....	.0298	....	
10,000	....	....	.0009	
110,000	....	.0338	....	
120,000	....	.0381	....	
130,000	....	.0425	....	
140,000	....	.0470	....	
150,000	....	.0529	....	
10,000	....	....	.0049	
160,000	....	.0594	....	
170,000	....	.0650	....	
180,000	....	.0705	....	
190,000	....	.0768	....	
200,000	....	.0848	....	Cracks opened in lower end course of bricks.
10,000	....	....	.0158	
210,000	....	.0943	....	
220,000	....	.0990	....	Cracks in four courses at lower end.
230,000	....	.1098	....	
240,000	....	.1185	....	
250,000	....	.1260	....	
10,000	....	....	.0315	
260,000	....	.1423	....	
270,000	....	.1530	....	
280,000	....	.1645	....	
290,000	....	.1855	....	Cracks extend from upper end through thirteen courses. At lower end through nine courses.
298,000	2,253	....	....	Ultimate strength.

This pier failed at the ends, cracks opening first in the end courses and extending towards the middle of its length. The lower end course began to flake off at 220,000 pounds, and thus continued during the remainder of the test.

COMMON BRICK PIERS.

No. 10.

8″ brick pier.

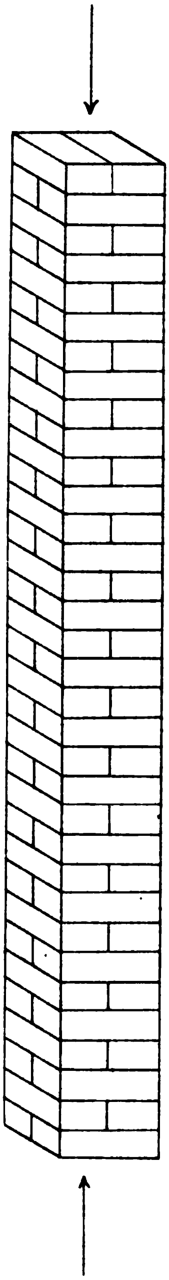
[Built of seven courses of common brick, laid in lime mortar. Composition of mortar, one part lime three parts sand. Age when tested, fifteen months.]

Total weight of pier, 78.5 pounds.
Weight per cubic foot, 135.6 pounds.
Total height, 16″.48.
Sectional area, 7″.8 × 7″.8 = 60.8 square inches.
Gauged length, 16″.48.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
2,000	....	.0060	....	
3,000	....	.0100	....	
4,000	....	.0140	....	
5,000	....	.0170	....	
6,000	....	.0200	....	
7,000	....	.0235	....	
8,000	....	.0250	....	
9,000	....	.0270	....	
10,000	....	.0290	....	
1,000	....	....	.0210	
10,000	....	.0300	....	
12,000	....	.0330	....	
14,000	....	.0370	....	
16,000	....	.0400	....	
18,000	....	.0440	....	
20,000	....	.0470	....	
1,000	....	....	.0320	
22,000	....	.0510	....	
24,000	....	.0540	....	
26,000	....	.0560	....	
28,000	....	.0590	....	
30,000	....	.0625	....	
1,000	....	....	.0430	
32,000	....	.0670	....	
34,000	....	.0690	....	
36,000	....	.0720	....	
38,000	....	.0740	....	
40,000	....	.0765	....	
42,000	....	.0790	....	
44,000	....	.0820	....	
46,000	....	.0845	....	
48,000	....	.0875	....	
50,000	....	.0908	....	
1,000	....	....	.0635	
52,000	....	.0958	....	
54,000	....	.0970	....	
56,000	....	.0995	....	
58,000	....	.1015	....	
60,000	....	.1040	....	
62,000	....	.1070	....	
64,000	....	.1100	....	
66,000	....	.1120	....	Crack in 5th course opposite adjacent end joint; mortar shells off.
68,000	....	.1160	....	
70,000	....	.1240	....	Crack in 3d course opposite adjacent end joint.
72,000	....	.1260	....	
74,000	....	.1280	....	
76,000	....	.1295	....	
78,000	....	.1340	....	
80,000	....	.1370	....	
1,000	....	....	.1000	
82,000	....	.1460	....	
84,000	....	.1470	....	
86,000	....	.1480	....	
88,000	....	.1500	....	

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
90, 000	....	.1530	....	
92, 000	....	.1550	....	
94, 000	....	.1565	....	
96, 000	....	.1580	....	
98, 000	....	.1620	....	
100, 000	....	.1645	....	
102, 000	....	.1670	....	
104, 000	....	.1690	....	
106, 000	....	.1710	....	
108, 000	....	.1720	....	
110, 000	....	.1770	....	
112, 000	....	.1820	....	
114, 000	....	.1830	....	
116, 000	....	.1850	....	
120, 000	....	.1930	....	
130, 000	....	.2040	....	
148, 400	2, 440	....	....	Ultimate strength.

No. 12½
8 inch Brick pier.



No. 12½.

8″ brick pier.

[Built of thirty-four courses of common brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Age, when tested, fifteen months.]

Total weight of pier, 386 pounds.
Weight, per cubic foot, 133.6 pounds.
Total height, 80″.05.
Sectional area, 7″.9×7″.9=62.4 square inches.
Pier cracked in transportation.
Gauged length, 80″.05.

Applied loads.		Compression.	Set.	Deflections.		Remarks.
Total.	Per square inch.			Horizontal.	Vertical.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	....	....	
6, 000	....	.0080	....	....	....	
7, 000	....	.0190	....	....	....	
8, 000	....	.0300	....	....	....	
9, 000	....	.0420	....	....	....	
10, 000	....	.0520	....	....	....	
5, 000	....	....	.0445	....	....	
10, 000	....	.0530	....	....	....	
12, 000	....	.0720	....	....	....	
14, 000	....	.0910	....	....	....	
16, 000	....	.1080	....	....	....	
18, 000	....	.1270	....	....	....	Snapping sounds, but no cracks in sight. Mortar at surface of joints starts off.
20, 000	....	.1400	....	.00½	....	
5, 000	....	....	.1175	....	....	
96, 100	1, 540	....	....	....	....	Ultimate strength.

No. 281.

12″ *brick pier.*

[Built of ten courses of common brick, laid in lime mortar. Composition of mortar, one part lime three parts sand. Age, when tested, eighteen and one-half months.]

Total height, 23″.90.
Sectional area, 11″.75×11″.75=138.06 square inches.
Gauged length, 23″.90.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0052		
15,000		.0114		
20,000		.0175		
25,000		.0237		
5,000			.0175	
25,000		.0252		
30,000		.0290		
34,000				Cracking sounds.
35,000		.0372		
40,000		.0440		
45,000		.0500		
50,000		.0575		
5,000			.0440	
50,000		.0600		
55,000		.0630		
60,000		.0690		
65,000		.0750		
70,000		.0810		
75,000		.0870		Cracks in end course.
5,000			.0662	
75,000		.0920		
80,000		.0970		
85,000		.1010		
90,000		.1100		
95,000		.1190		
100,000		.1220		
5,000			.0922	
100,000		.1265		
105,000		.1300		
110,000		.1325		
115,000		.1395		
120,000		.1480		
125,000		.1525		Longitudinal cracks generally developed in bricks opposite joints in adjacent courses.
130,000		.1635		
135,000		.1680		
140,000		.1720		
145,000		.1790		
150,000		.1840		
160,000		.1910		
170,000		.2050		
180,000		.2152		
190,000		.2250		
200,000		.2355		
296,400	2,150			Ultimate strength.

No. 282.

12″ brick pier with hollow center.

[Built of ten courses of common brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Age when tested, eighteen and one-half months.]

Total height, 23″.90.
Dimensions of cross-section, 11″.75×11″.90=139.83 square inches.
Dimensions of hollow center, 4″.5×4″.5=20.25 square inches.
Sectional area, 119.58 square inches.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0102	....	
25,000	....	.0148	....	
5,000	....	....	.0115	
25,000	....	.0165	....	
30,000	....	.0200	....	
35,000	....	.0250	....	
40,000	....	.0295	....	
45,000	....	.0350	....	Cracking sounds.
50,000	....	.0395	....	
5,000	....	....	.0302	
50,000	....	.0430	....	
55,000	....	.0460	....	
60,000	....	.0520	....	
65,000	....	.0580	....	
70,000	....	.0660	....	
75,000	....	.0730	....	
5,000	....	....	.0560	
75,000	....	.0772	....	
80,000	....	.0825	....	
85,000	....	.0890	....	
90,000	....	.0980	....	
95,000	....	.1065	....	
100,000	....	.1130	....	
5,000	....	....	.0900	
100,000	....	.1200	....	
110,000	....	.1305	....	
120,000	....	.1480	....	Cracks in sight in 3d, 5th, and 7th courses.
130,000	....	.1645	....	
140,000	....	.1800	....	
150,000	....	.1950	....	
160,000	....	.2160	....	
170,000	....	.2260	....	
180,000	....	.2410	....	
190,000	....	.2560	....	
200,000	....	.2755	....	
244,600	2,050	....	....	Ultimate strength.

No. 331.

12″ *brick pier.*

[Built of 49 courses of common brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Joints between 13th and 14th courses, and 36th and 37th courses, were broken in transportation. They were rejoined with plaster-of-paris. Age when tested, twenty-four months.]

Total weight of pier, 1,234 pounds.
Weight per cubic foot, 131.5 pounds.
Total height, 117$\frac{5}{8}$″.
Sectional area, 11″.75×11″.75=138.06 square inches.
Average thickness of joints, $\frac{1}{4}$″.
Gauged length, 100″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0084	....	
30,000	....	.0245	....	
40,000	....	.0854	....	
50,000	....	.1550	....	
10,000	....	....	.1218	
60,000	....	.2275	....	
70,000	....	.3050	....	Cracks opened in courses next the plastered joints.
80,000	....	.3610	....	
90,000	....	.4195	....	
100,000	....	.4816	....	
10,000	....	....	.3900	
110,000	....	.5410	....	
120,000	....	.5965	....	
130,000	....	.6480	....	
140,000	....	.7140	....	
154,300	1,118	....	....	Ultimate strength.

Failed by opening longitudinal seams.

One of the plaster-of-paris joints varied in thickness from $\frac{1}{4}$″ to $\frac{3}{8}$″. The brick-work was most injured in the vicinity of, and on the side of, the pier having the closest joint.

No. 330.

12″ brick pier with hollow center.

[Built of 50 courses of common brick laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, ½″. Age when tested, twenty-four months.]

Total weight of pier, 1,095 pounds.
Weight per cubic foot, 136 pounds.
Total height, 120⅜″.
Dimensions of cross-section, 11″.75 × 11″.75=138.06 square inches.
Dimensions of hollow center, 4″.75 × 4″.75=22.56 square inches.
Sectional area, 115.5 square inches.
Gauged length, 100″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0100	....	
30,000	....	.0243	....	
40,000	....	.0659	....	
50,000	....	.1120	....	
10,000	....	....	.0729	
60,000	....	.1553	....	
70,000	....	.2048	....	Crack opened in 15th course.
80,000	....	.2456	....	
10,000	....	....	.1759	
90,000	....	.2995	....	
100,000	....	.3468	....	
10,000	....	....	.2548	
110,000	....	.3980	....	
120,000	....	.4350	....	
130,000	....	.4912	....	
140,000	....	.5365	....	Cracks very generally developed along entire length.
150,000	....	.5912	....	
160,000	....	.6475	....	
165,500	....	.6770	....	
183,300	1,587	....	....	Ultimate strength.

Seams opened from end to end of the pier. Bricks partially crushed in six courses near the middle, and in the eighth course from the end.

No. 329.

92″ brick pier.

[Built of 48 courses of common brick, laid in cement mortar. Composition of mortar, one part Portland cement, two parts sand. Average thickness of joints, ¼″. Age when tested, twenty-four months.]

Total weight of pier, 1,256 pounds.
Weight per cubic foot, 131 pounds.
Total height, 120″.
Sectional area, 11″.75×11″.75=138.06 per square inch.
Gauged length, 100″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000		0.		
20,000		.0031		
30,000		.0067		
40,000		.0124		
50,000		.0184		
10,000			.0029	
60,000		.0242		
70,000		.0289		
80,000		.0338		
90,000		.0385		
100,000		.0425		
10,000			.0066	
110,000		.0466		
120,000		.0503		
130,000		.0544		
140,000		.0594		
150,000		.0642		
10,000			.0083	
160,000		.0703		
170,000		.0760		
180,000		.0813		
190,000		.0894		Cracks in sight at end courses.
200,000		.0982		
10,000			.0164	
210,000		.1084		
220,000		.1156		
230,000		.1239		
240,000		.1834		
250,000		.1439		
10,000			.0325	
260,000		.1670		
276,600	2,003			Ultimate strength.

Failure occurred by opening longitudinal seams, which began at the ends of the pier and extended towards the middle.

Under the maximum load the largest seam extended one-third the length of the pier and was open ⅜″.

No. 328.

16″ *brick pier.*

[Built of forty-nine courses of common brick, laid in cement mortar. Composition of mortar, one part Portland cement, two parts sand. Average thickness of joints, ½″. Age when tested, twenty-four months.]

Total length, 121″.
Sectional area, 16″×16″=256 square inches.
Gauged length, 100″.

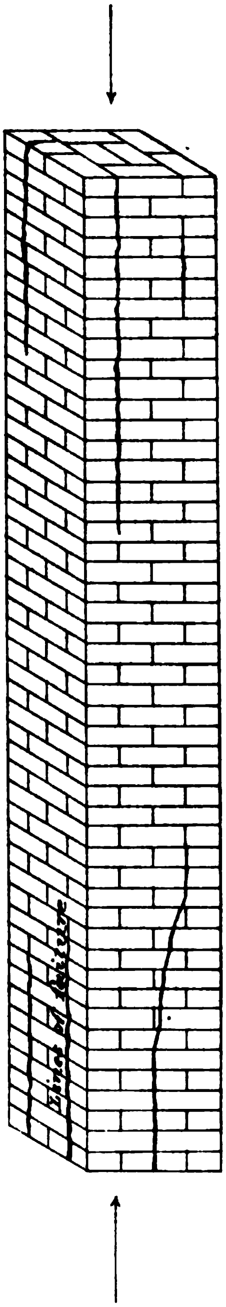
Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
20,000		0.		
40,000		.0024		
60,000		.0065		
80,000		.0132		
100,000		.0190		
20,000			.0042	
120,000		.0235		
140,000		.0278		
160,000		.0289		
180,000		.0322		
200,000		.0351		
20,000			.0021	
40,000		.0039		Loads and readings repeated up to 200,000 pounds, on account of probable errors in the first readings.
60,000		.0074		
80,000		.0113		
100,000		.0153		
20,000			.0021	
120,000		.0191		
140,000		.0230		
160,000		.0271		
180,000		.0312		
200,000		.0352		
20,000			.0024	
220,000		.0394		
240,000		.0444		
260,000		.0496		
280,000		.0553		
300,000		.0619		
20,000			.0067	
320,000		.0687		
340,000		.0763		Cracks developed in 5 courses at lower end.
360,000		.0841		
380,000		.0928		
400,000		.1017		
20,000			.0164	
420,000		.1155		Cracks developed in courses at the upper end of pier.
440,000		.1274		
460,000		.1427		Cracks now extend from each end one-third the length of pier.
483,100	1,887			Ultimate strength.

Failure occurred by the development of longitudinal seams, which began at the ends of the pier and extended towards the middle, following the end joints of the bricks, 3½″ to 4″ from the corners of the pier.

At the lower end one seam was opened along the middle of one side, extending through six courses, thence obliquely to the end joints 4″ from corner of pier.

No. 328

16 inch Brick pier.



S Ex 35 49 1

BAY STATE BRICK PIERS.

No. 285.

12″ brick pier.

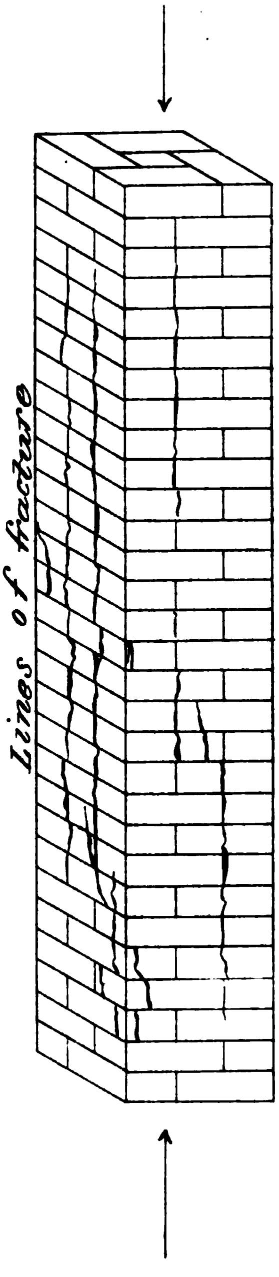
[Built of ten courses of Bay State brick laid in lime mortar. Composition of mortar, one part lime three parts sand. Age when tested, eighteen and one-half months.]

Total height, 24″.10.
Sectional area, 12″.10×12″.10=146.41 square inches.
Gauged length, 24″.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0060	....	
15,000	....	.0114	....	
20,000	....	.0170	....	
25,000	....	.0230	....	
5,000	....	....	.0140	
25,000	....	.0235	....	
30,000	....	.0278	....	
35,000	....	.0325	....	
40,000	....	.0370	....	
45,000	....	.0410	....	
50,000	....	.0470	....	
5,000	....	....	.0300	
50,000	....	.0490	....	
55,000	....	.0520	....	
60,000	....	.0565	....	
65,000	....	.0610	....	
70,000	....	.0642	....	
75,000	....	.0705	....	Snapping sounds. No cracks in sight.
5,000	....	....	.0460	
75,000	....	.0730	....	
80,000	....	.0760	....	
85,000	....	.0800	....	
90,000	....	.0840	....	
95,000	....	.0890	....	One brick in end course begins to crack.
100,000	....	.0950	....	
5,000	....	....	.0620	
100,000	....	.1020	....	Rested under this load 10 minutes.
110,000	....	.1040	....	
120,000	....	.1120	....	
130,000	....	.1240	....	
140,000	....	.1370	....	
150,000	....	.1540	....	
160,000	....	.1655	....	
170,000	....	.1780	....	
180,000	....	.1960	....	
190,000	....	.2145	....	
200,000	....	.2480	....	
201,000	1,370	....	....	Ultimate strength.

No. 288

12 inch Brick pier.



No. 288.

12″ brick pier.

[Built of thirty courses of Bay State brick laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, $\frac{3}{16}$″. Age when tested, nineteen and a half months.]

Total height, 72″.5.
Sectional area, 12″×12″=144 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0095	....	
30,000	....	.0230	....	
40,000	....	.0366	....	
50,000	....	.0516	....	Snapping sounds.
10,000	....	....	.0347	
50,000	....	.0536	....	
60,000	....	.0664	....	
70,000	....	.0826	....	Crack in third course of bricks.
80,000	....	.0990	....	Cracks in sight in two other courses.
90,000	....	.1150	....	
100,000	....	.1319	....	
10,000	....	....	.0923	
100,000	....	.1372	....	
110,000	....	.1520	....	
117,000	....	.1617	....	Sudden yielding. Micrometer removed. Numerous longitudinal cracks opened.
163,200	1,133	....	....	Ultimate strength.

There was a gradual development of longitudinal cracks in the brick work after those first observed, as the pressure was increased, accompanied by frequent snapping sounds.

The longitudinal seams opened widest along the middle of the pier, the sides slightly swelling in each of the four directions.

Under the maximum load hardly a brick escaped fracture by splitting into halves; fractures occurring opposite the joints of adjacent courses.

No. 289.

12'' *brick pier.*

[Showing the effect of repeated loading. Built of thirty courses of Bay State brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, $\frac{3}{16}$''. Age when tested, nineteen and one-half months.]

Total weight of pier, 728 pounds.
Weight per cubic foot, 119.7 pounds.
Total height, 73''.
Sectional area, 12''×12''=144 square inches.
Gauged length, 50''.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0103	....	
....	....	.0109	....	After sustaining load five minutes.
10,000	....	....	.0065	
....	....	....	.0066	Do.
20,000	....	.0114	....	
30,000	....	.0230	....	
....	....	.0245	....	Do.
10,000	....	....	.0148	
....	....	....	.0149	Do.
20,000	....	.0204	....	
30,000	....	.0248	....	
40,000	....	.0362	....	
....	....	.0382	....	Do.
10,000	....	....	.0237	
....	....	....	.0236	Do.
20,000	....	.0291	....	
30,000	....	.0340	....	
40,000	....	.0390	....	
50,000	....	.0504	....	
....	....	.0527	....	Do.
10,000	....	....	.0328	
....	....	....	.0327	Do.
20,000	....	.0389	....	
30,000	....	.0439	....	
40,090	....	.0487	....	
50,000	....	.0535	....	
60,000	....	.0642	....	Snapping sounds heard.
....	....	.0675	....	After sustaining load five minutes.
10,000	....	....	.0427	
....	....	....	.0425	Do.
20,000	....	.0485	....	
30,000	....	.0541	....	
40,000	....	.0591	....	
50,000	....	.0635	....	
60,000	....	.0684	....	
70,000	....	.0790	....	
....	....	.0834	....	Do.
10,000	....	....	.0540	
10,000	....	....	.0536	Do.
20,000	....	.0603	....	
30,000	....	.0660	....	
40,000	....	.0710	....	
50,090	....	.0756	....	
60,000	....	.0797	....	
70,000	....	.0843	....	
80,000	....	.0955	....	
....	....	.0994	....	Do.
10,000	....	....	.0653	
....	....	....	.0649	Do.
....	....	....	.0646	After sustaining load sixty-five minutes.
20,000	....	.0714	....	
30,000	....	.0774	....	
40,000	....	.0824	....	
50,050	....	.0877	....	
60,000	....	.0920	....	

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
70,000		.0958		
80,000		.1007		
90,000		.1105		
		.1162		After sustaining load five minutes.
10,000			.0773	
			.0769	Do.
			.0767	After sustaining load fifteen minutes.
			.0766	After sustaining load twenty-five minutes.
20,000		.0835		
30,000		.0898		
40,000		.0951		
50,000		.1003		
60,000		.1050		
70,000		.1088		
80,000		.1130		
90,000		.1180		
100,000		.1305 ?		Crack in fourteenth course of bricks.
		.1334		After sustaining load five minutes.
10,000			.0908	
			.0902	
20,000		.0972		
30,000		.1036		
40,000		.1094		
50,000		.1145		
60.000		.1192		
70,000		.1232		
80,000		.1269		
90,000		.1310		
100,000		.1364		
110,000		.1450		
		.1518		Do.
10,000			.1041	
			.1033	Do.
20,000		.1105		
30,000		.1174		
40,000		.1233		
50,000		.1284		
60,000		.1329		
70,000		.1374		
80,000		.1412		
90,000		.1453		
100,000		.1493		
110,000		.1551		
120,000		.1673		Cracks in sight in thirteen courses.
		.1718		After sustaining load five minutes.
10,000			.1198	
			.1191	Do.
20,000		.1262		
30,000		.1328		
40,000		.1390		
50,000		.1442		
60,000		.1489		
70,000		.1532		
80,000		.1574		
90,000		.1614		
100,000		.1653		
110,000		.1699		
120,000		.1748		
130,000		.1872		
		.1908		Do.
10,000			.1345	
			.1337	
174,300	1,210			Ultimate strength.

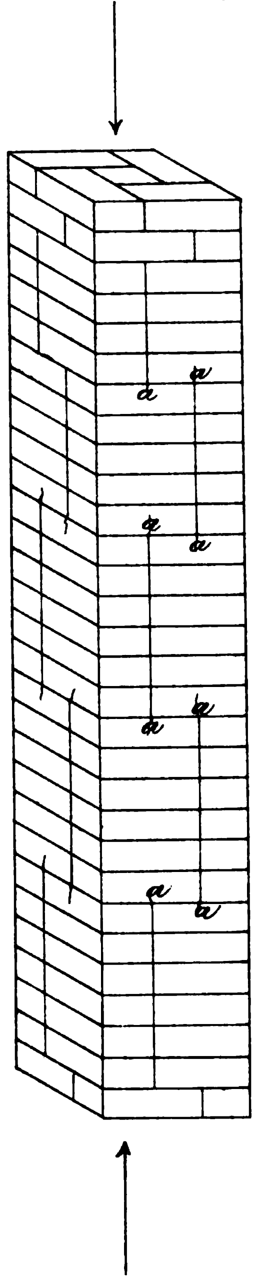
Failed by opening longitudinal seams.

When the test was discontinued, the pressure sustained was about 150,000 pounds, the widest seam being open ⅝″ at the middle of the pier.

No. 291

12 inch Brick pier.

Joints broken every six courses.



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No. 291.

12″ *brick pier.*

[Built of thirty courses of Bay State brick, laid in lime mortar. Composition of mortar, one part lime and three parts sand. Joints broken every six courses. Age when tested, twenty months.]

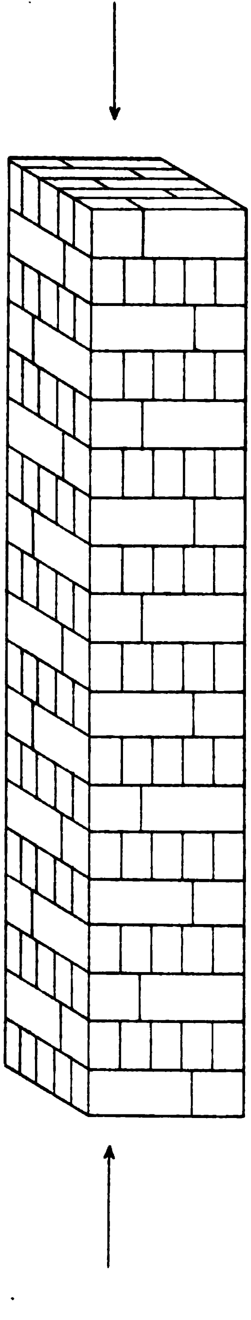
Average thickness of joints, $\frac{3}{16}$″.
Total weight of pier, 712 pounds.
Weight per cubic foot, 118.2 pounds.
Total height, 72″.25.
Sectional area, 12″ × 12″ = 144 square inches.
Gauged length (fifth to twenty-sixth courses, inclusive), 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000		0.		
20,000		.0065		
30,000		.0092		
40,000		.0216		
50,000		.0352		Snapping sounds.
60,000		.0494		
70,000		.0625		
80,000		.0785		Crack opened in the eighteenth course opposite the joint of the seventeenth course, crack also opened in the twenty-ninth course.
90,000		.0935		
100,000		.1107		Cracks generally started opposite joints as indicated by letters *a* on the sketch. The mortar of the joints showing slight longitudinal openings.
10,000			.0744	
100,000		.1164		
110,000		.1266		
120,000		.1446		
130,000		.1614		
140,000		.1805		
150,000		.1953		Bricks in thirteenth and seventeenth courses flake off at sides.
191,600	1 331			Ultimate strength.

The pier yielded rapidly under the pressure of 186,400 pounds, the load falling to 184,000 pounds. It then recovered, and the pressure was gradually increased to the maximum 191,600 pounds.

Failure occurred by opening longitudinal seams in continuation of the end joints of the bricks.

No. 292
12 inch Brick pier.
Bricks laid on edge.



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No. 292.

12" brick pier.

[Built of nineteen courses of Bay State bricks, laid on edge in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, ½". Age when tested, twenty months.]

Total weight of pier, 780 pounds.
Weight per cubic foot, 118.1 pounds.
Total height, 73".
Sectional area, 12".5 × 12".5=156.25 square inches.
Gauged length, 50".

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000		0.		
20,000		.0032		
30,000		.0100		
40,000		.0193		
50,000		.0281		
10,000			.0143	
50,000		.0291		
60,000		.0369		
70,000		.0459		
80,000		.0548		
90,000		.0639		
100,000		.0726		
10,000			.0402	
100,000		.0762		
110,000		.0828		Longitudinal seams opened in three courses near middle of pier.
120,000		.0917		
130,000		.1018		Corner brick in third course flakes off.
140,000		.1114		
189,200	1,211			Ultimate strength.

Opened longitudinal seams. Bricks in three courses near middle of pier, partially crushed.

No. 325.

12″ *brick pier.*

[Built of thirty-nine courses of Bay State brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, $\frac{3}{16}$″. Age when tested, twenty-three and one-half months.]

Total weight of pier, 945 pounds.
Weight per cubic foot, 120.3 pounds.
Total height, 91″.25.
Sectional area, 12″ × 12″=144 square inches.
Gauged length, 80″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0074	....	
30,000	....	.0194	....	
40,000	....	.0407	....	
50,000	....	.0609	....	
10,000	....	....	.0300	
60,000	....	.0822	....	
70,000	....	.1045	....	
80,000	....	.1268	....	
90,000	....	.1507	....	
100,000	....	.1748	....	Cracks opened in three courses near the middle of the pier.
10,000	....	....	.1061	
110,000	....	.2049	....	
120,000	....	.2312	....	
130,000	....	.2550	....	
140,000	....	.2910	....	
150,000	....	....	....	Pier covered with canvas.
169,100	1,174	....	....	Ultimate strength.

At 150,000 pounds pressure longitudinal seams were developed the entire length of the pier.

After passing the maximum load the pressure was continued, while the load gradually fell to 140,000 pounds, when the test was discontinued.

Seams were opened along each face of the pier, separating it into a clustered column, composed of half bricks.

No. 327.

12″ *brick pier.*

[Built of forty-nine courses of Bay State brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, $\frac{1}{16}$″. Age when tested, twenty-three and one-half months.]

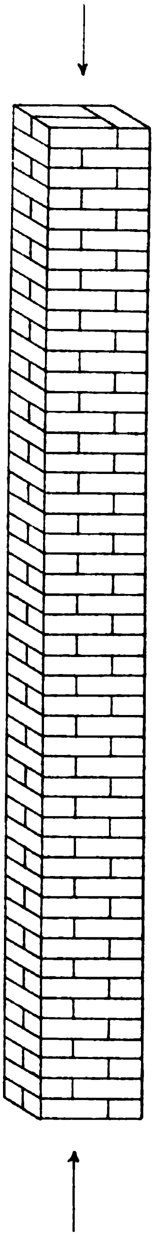
Total weight of pier, 1,177 pounds.
Weight per cubic foot, 118 pounds.
Total height, 119″.60.
Sectional area, 12″×12″=144 square inches.
Gauged length, 100″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000	....	0.	....	
20,000	....	.0090	....	
30,000	....	.0180	....	
40,000	....	.0428	....	
50,000	....	.0758	....	
10,000	....	....	.0382	
60,000	....	.1117	....	
70,000	....	.1493	....	
80,000	....	.1870	....	
90,000	....	.2275	....	Cracks opened in courses near the middle of the pier.
100,000	....	.2710	....	
10,000	....	....	.1815	
110,000	....	.3130	....	
120,000	....	.3705	....	
130,000	....	.4150	....	
133,100	924	....	....	Ultimate strength.

Failed by the partial crushing of bricks near the middle of the pier on the under side, causing upward deflection at the middle.

Longitudinal seams were gradually opened by pressures above 90,000 pounds until they extended from end to end, when the maximum load was reached. Pressure was continued, opening the longitudinal seams $\frac{1}{2}$″ in width, the load which the pier was capable of sustaining falling to 125,000 pounds, when the test was discontinued.

No. 335
8 by 12 inch Brick pier.



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No. 335.

8"×12" *brick pier.*

[Built of forty-nine courses of Bay State brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, ½". Joints between the 11th and 12th, the 21st and 22nd, the 27th and 28th, the 33rd and 34th, and the 40th and 41st courses were broken in transportation. The first three were rejoined with lime mortar and the last two with plaster of paris. The pier was tested when the rejoined courses had stood one day. Age when tested, 24 months.]

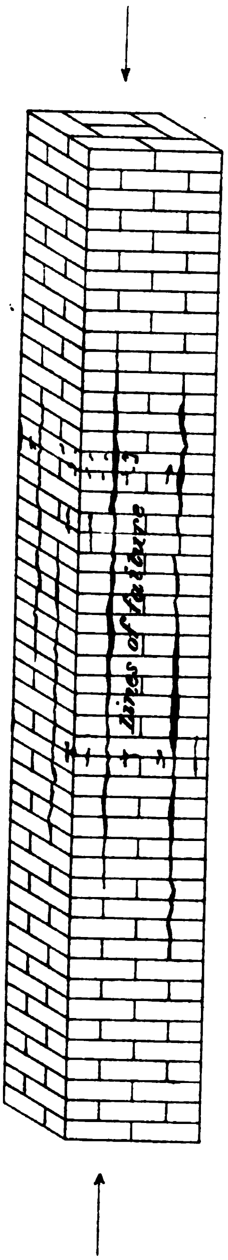
Total weight of pier, 719 pounds.
Weight per cubic foot, 107 pounds.
Total height, 120¾".
Sectional area, 8"×12"=96 square inches.
Gauged length, 100".

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inches.*	*Inches.*	
10,000	....	0.	....	
15,000	....	.0058	....	
20,000	....	.0166	....	
25,000	....	.0445	....	
10,000	....	....	.0273	
30,000	....	.0810	....	
35,000	....	.1081	....	Cracks opened in 22d and 24th courses.
40,000	....	.1414	....	
45,000	....	.1876	....	Further development of cracks in the vicinity of courses that were rejoined with lime mortar.
50,000	....	.2190	....	
10,000	....	....	.1655	
55,000	....	.2568	....	
60,000	....	.2950	....	Cracks opened in the 33d, 34th, and 35th courses.
65,000	....	.3200	....	
70,000	....	.3756	....	
75,000	....	.4127	....	
80,000	....	.4505	....	
90,200	940	....	....	Ultimate strength.

Failure occurred by partially crushing the bricks of the courses that had been rejoined with lime mortar and by opening longitudinal seams.

The end having the courses that were rejoined with plaster of paris was less injured.

No. 333
12 by 16 inch Brick pier.



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No. 333.

12"×16" *brick pier.*

[Built of forty-nine courses of Bay State brick, laid in lime mortar. Composition of mortar, one part lime, three parts sand. Average thickness of joints, ½". Joints between 19th and 20th, and 33d and 34th courses were broken in transportation. They were rejoined with plaster of paris. Age when tested, twenty-four months.]

Total weight of pier, 1,590 pounds.
Weight per cubic foot, 118.7 pounds.
Total height, 120½".
Sectional area, 12"×16"=192 square inches.
Gauged length, 100".

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inches.*	*Inches.*	
20,000		0.		
30,000		.0054		
40,000		.0225		
50,000		.0621		
20,000			.0440	
60,000		.0932		
70,000		.1374		
80,000		.1824		Cracks opened in 31st to 36th courses, inclusive.
90,000		.2293		
100,000		.2726		Cracks generally developed along the middle of the pier on one 16" face.
20,000			.2164	
110,000		.3173		
120,000		.3590		
130,000		.4034		
140,000		.4982		
148,500	773			Ultimate strength.

Failed by crushing the bricks in the 19th, 20th, 33d, and 34th courses, and opening longitudinal seams along the middle part of the pier.

The first indications of failure occurred in the vicinity of the plaster-of-paris joints.

Under 100,000 pounds pressure the cracks were chiefly developed on one of the 16" faces. At this time only two cracks were in sight on the other 16" face. One 12" face had one crack, and the other had none. Near the close of the test the cracks became general on all faces.

The test was discontinued when the sustaining power of the pier was reduced to 135,000 pounds, when seams ½ inch in width were opened, and the length of pier shortened ".6.

No. 301.

12″ brick pier.

[Built of thirty courses of Bay State brick, laid in a mortar, composed of two parts lime mortar, one part Rosendale cement. The composition of lime mortar, one part lime, three parts sand. Average thickness of joints, $\frac{3}{8}$″. Age when tested, twenty and a half months.]

Total weight of pier, 740 pounds.
Weight per cubic foot, 120.6 pounds.
Total height 73$\frac{5}{8}$″.
Sectional area, 12″ × 12″=144 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inches.*	*Inches.*	
10,000		0.		
20,000		.0016		
30,000		.0044		
40,000		.0077		
50,000		.0129		
10,000			0.0027	
60,000		.0189		
70,000		.0242		
80,000		.0305		
90,000		.0367		
100,000		.0428		
10,000			.0129	
100,000		.0447		
110,000		.0501		
120,000		.0572		
130,000		.0637		
140,000		.0705		
150,000		.0789		
10,000			.0284	
150,000		.0820		
160,000		.0880		Cracks opened in 3d, 5th, 6th, and 8th courses from north end; also in 3d and 5th courses from the south end of pier.
170,000		.0971		
180,000		.1043		
237,000	1,646			Ultimate strength.

Pier failed by opening longitudinal seams.

No. 293.

12″ *brick pier.*

[Built of thirty courses of Bay State brick laid in mortar, composed of one part Rosendale cement, two parts sand. Average thickness of joints, $\frac{3}{16}$″. Age when tested, twenty months.]

Total weight of pier, 740 pounds.
Weight per cubic foot, 123 pounds.
Total height, $72\frac{1}{8}$″.
Sectional area, 12″×12″=144 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inches.*	*Inches.*	
10, 000	....	0.	....	
20, 000	....	.0014	....	
30, 000	....	.0035	....	
40, 000	....	.0058	....	
50, 000	....	.0086	....	
10, 000	....	....	.0014	
50, 000	....	.0091	....	
60, 000	....	.0116	....	
70, 000	....	.0149	....	
80, 000	....	.0182	....	
90, 090	....	.0216	....	
100, 000	....	.0249	....	
10, 000	....	....	.0050	
100, 000	....	.0254	....	
110, 000	....	.0279	....	
120, 000	....	.0313	....	
130, 000	....	.0353	....	
140, 000	....	.0389	....	
150, 000	....	.0431	....	
10, 000	....	....	.0098	
150, 000	....	.0443	....	
160, 000	....	.0476	....	
170, 000	....	.0515	....	
180, 000	....	.0566	....	
190, 000	....	.0621	....	
200, 000	....	.0677	....	
10, 000	....	....	.0185	
200, 000	....	.0694	....	
210, 000	....	.0736	....	
220, 000	....	.0783	....	Snapping sounds, but no cracks in sight.
230, 000	....	.0846	....	
240, 900	....	.0913	....	
250, 000	....	.9068	....	
10, 000	....	....	.0307	
250, 000	....	.1013	....	
260, 000	....	.1075	....	Longitudinal seams opened in 7th and 10th courses from the north end. Corner of 2d course from south end flakes.
270, 000	....	.1157	....	Seams opened in 3d to 7th courses inclusive, north end.
284, 000	1, 972	....	....	Ultimate strength.

The pressure gradually fell from the highest load to 240,000 pounds, when the test was discontinued.

The pier was most seriously injured from the middle towards the north end. Bricks in the 5th, 7th, and 11th courses were partially crushed.

No. 300.

12″ *brick pier.*

[Built of thirty courses of Bay State brick, laid in a mortar composed of two parts lime mortar, one part Portland cement. The composition of the lime mortar, one part lime, three parts sand. Average thickness of joints, $\frac{3}{16}$″. Age when tested, twenty and a half months.]

Total weight of pier, 736 pounds.
Weight per cubic foot, 120.3 pounds.
Total height, 73⅜″.
Sectional area, 12 × 12 = 144 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inches.*	*Inches.*	
10,000		0.		
20,000		.0011		
30,000		.0045		
40,000		.0089		
50,000		.0148		
10,000			.0031	
60,000		.0203		
70,000		.0257		
80,000		.0312		
90,000		.0373		
100,000		.0425		
10,000			.0128	
110,000		.0495		
120,000		.0542		
130,000		.0604		
140,000		.0660		
150,000		.0726		Cracks opened in 3d course from north end; also in two courses near middle of pier.
10,000			.0262	
150,000		.0757		
160,000		.0813		
170,000		.0875		
180,000		.0950		
190,000		.1013		Longitudinal seams generally developed near each end of pier.
203,200	1,411			Ultimate strength.
170,000				Load on pier when test was discontinued.

Longitudinal seams, having a maximum width of ⅝″ at the middle of the pier, opened from end to end, separating it into a clustered pier composed of nine piers of half bricks.

No. 294.

12″ brick pier.

[Built of twenty-nine courses of Bay State brick, laid in mortar composed of one part Portland cement, two parts sand. Average thickness of joints, $\frac{3}{16}$″. Age when tested, twenty months.]

Total weight of pier, 724 pounds.
Weight per cubic foot, 119.7 pounds.
Total height, 72″.6.
Sectional area, 12×12=144 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inches.*	*Inches.*	
10,000	....	0.	....	
20,000	....	.0009	....	
30,000	....	.0026	....	
40,000	....	.0049	....	
50,000	....	.0071	....	
10,000	....	....	.0004	
50,000	....	.0076	....	
60,000	....	.0102	....	
70,000	....	.0134	....	
80,000	....	.0169	....	
90,000	....	.0206	....	
100,000	....	.0247	....	
10,000	....	....	.0040	
100,000	....	.0256	....	
110,000	....	.0284	....	
120,000	....	.0324	....	
130,000	....	.0357	....	
140,000	....	.0404	....	
150,000	....	.0448	....	
10,000	....	....	.0103	
150,000	....	.0469	....	
160,000	....	.0504	....	
170,000	....	.0545	....	
180,000	....	.0590	....	
190,000	....	.0639	....	Sharp, snapping sounds; no cracks in sight.
200,000	....	.0700	....	
10,000	....	....	.0200	
200,000	....	.0724	....	
210,000	....	.0768	....	
220,000	....	.0821	....	Longitudinal seams opened in 2d, 4th, and 6th courses from south end.
230,000	....	.0882	....	
240,000	....	.0932	....	General development of seams at south end of pier.
258,000	1,792	....	....	Ultimate strength.
140,000	....	....	....	Load sustained when test was discontinued.

The south end of the pier was most injured by the test. Seams opened on each face, following the end joints of the bricks, half the length of the pier, then taking oblique direction to the corners of the pier.

No. 290.

12″ *brick pier.*

[Built of thirty courses of Bay State brick, laid in clear Portland cement. Average thickness of joints, $\frac{3}{16}$″. Age when tested, nineteen and one-half months.]

Total weight of pier, 760 pounds.
Weight per cubic foot, 126.6 pounds.
Total height, 72″.
Sectional area, 12″×12″=144 square inches.
Gauged length, 50″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10, 000		0.		
20, 000		.0000		
30, 000		.0015		
40, 000		.0037		
50, 000		.0060		
60, 000		.0085		
70, 000		.0112		
80, 000		.0140		
90, 000		.0165		
100, 000		.0192		
10, 000			—.0005	
100, 000		.0192		
110, 000		.0217		
120, 000		.0238		
130, 000		.0260		
140, 000		.0288		
150, 000		.0317		
160, 000		.0352		
170, 000		.0380		
180, 000		.0412		
190, 000		.0441		
200, 000		.0477		
10, 000			.0054	
200, 000		.0495		
210, 000		.0521		
220, 000		.0548		
230, 000		.0577		
240, 000		.0607		
250, 000		.0641		
260, 000		.0680		
270, 000		.0710		
280, 000		.0743		Cracks opened in eleventh and fifteenth courses. End course begins to flake.
290, 000		.0790		
300, 000		.0851		
10, 000			.0183	
300, 000		.0875		Seam opened through seven courses along the middle of the height of the pier.
342, 000	2, 375			Ultimate strength.

Load sustained when test was discontinued, 300,000 pounds.
Longitudinal seams opened.
Bricks in the 2d, 3d, 4th, 5th, and 8th courses were crushed; those of the other courses were split into halves generally, the fragments of which were apparently as hard as before the test.

DIAGRAMS

SHOWING THE

COMPRESSION OF MORTAR CUBES AND BRICK PIERS.

2

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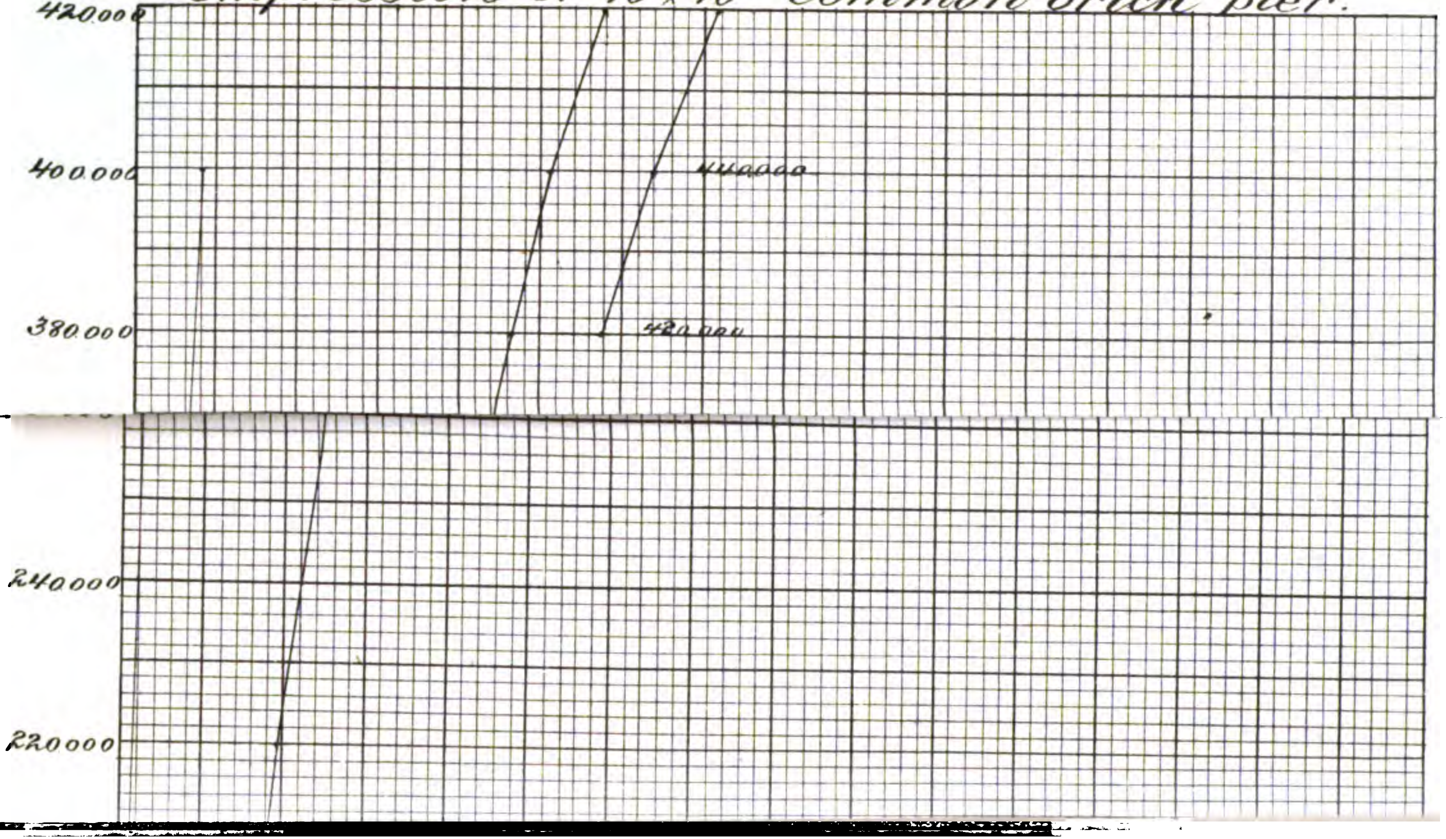
Compression of 16" x 16" common brick pier.



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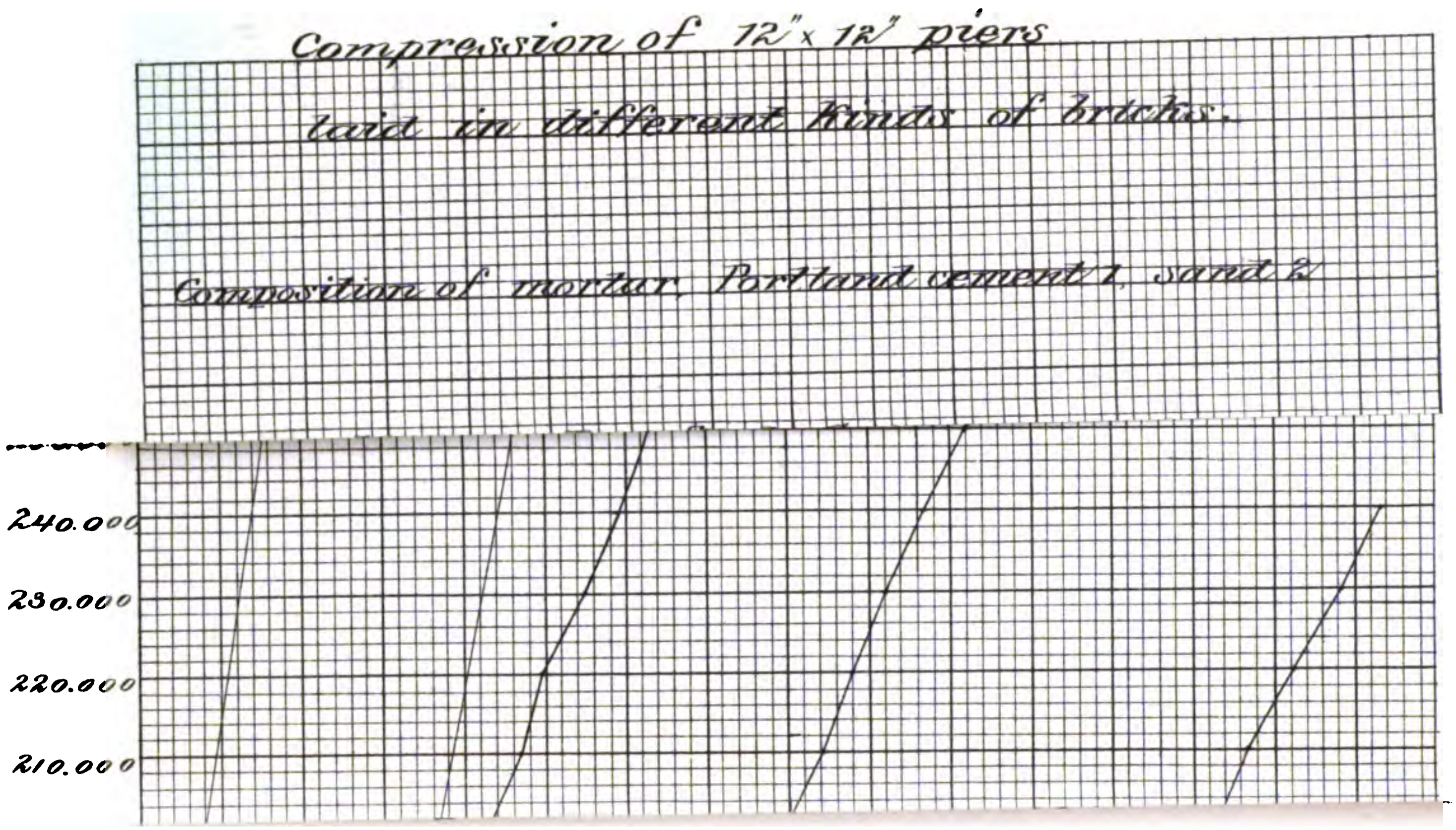
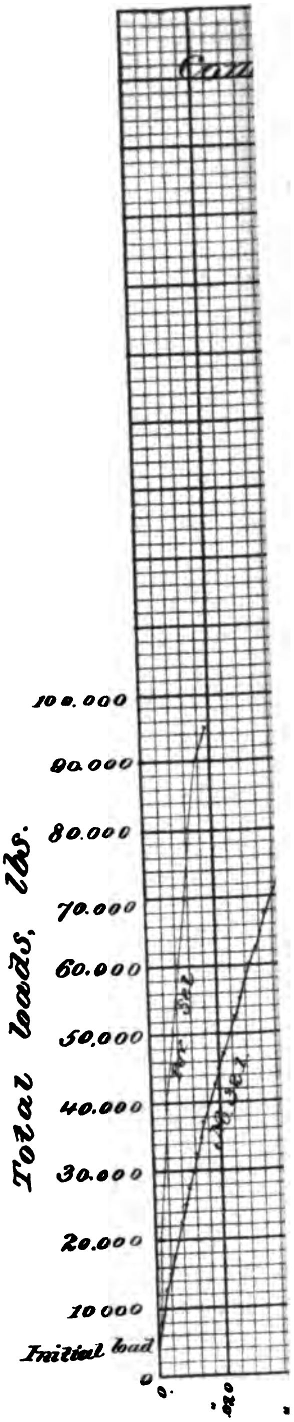


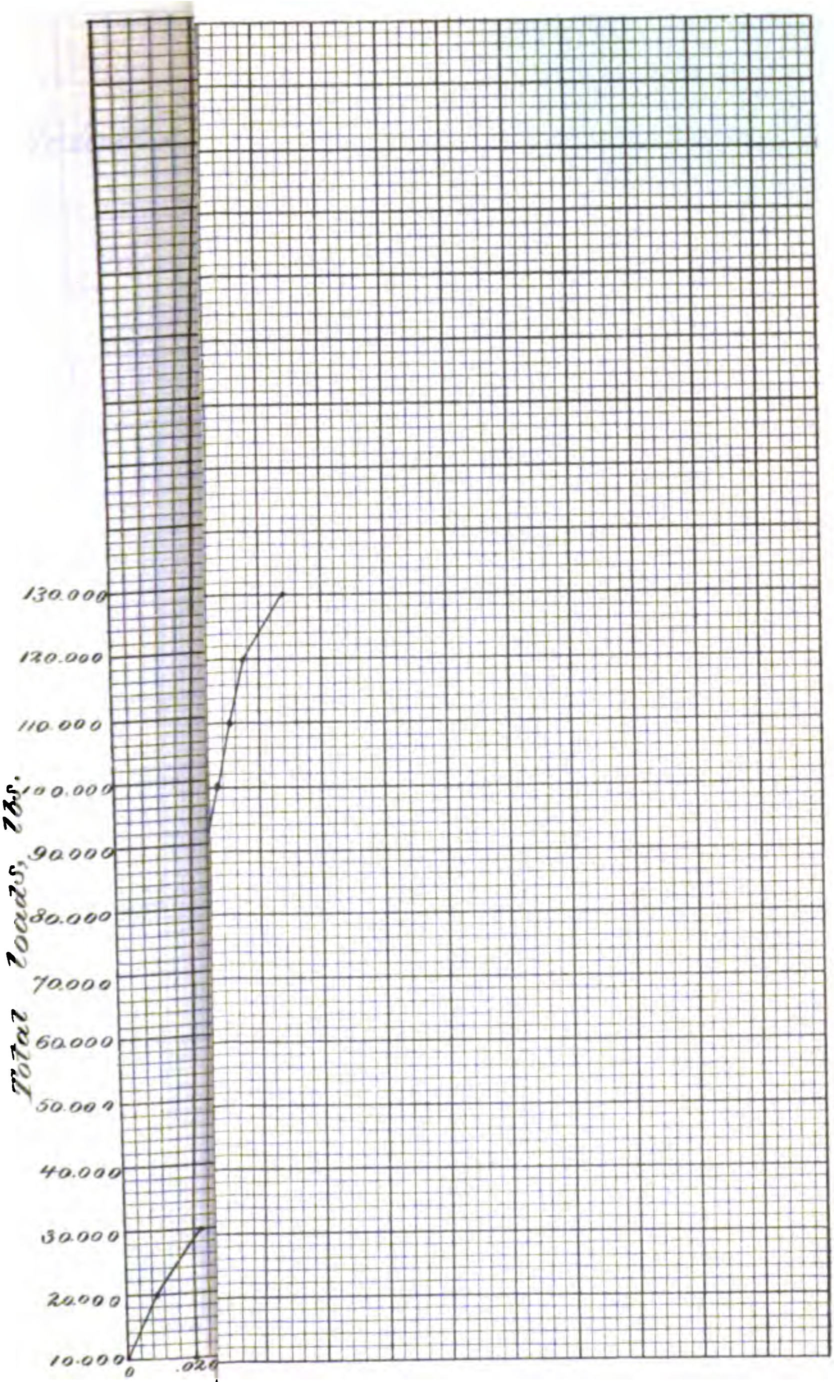
Compression of 12" x 12" piers

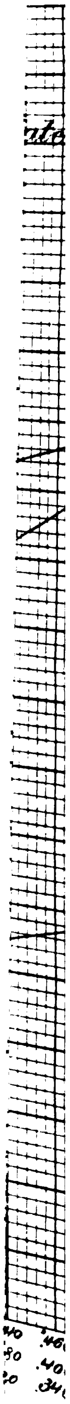
laid in different kinds of bricks.

Composition of mortar, Portland cement 1, sand 2

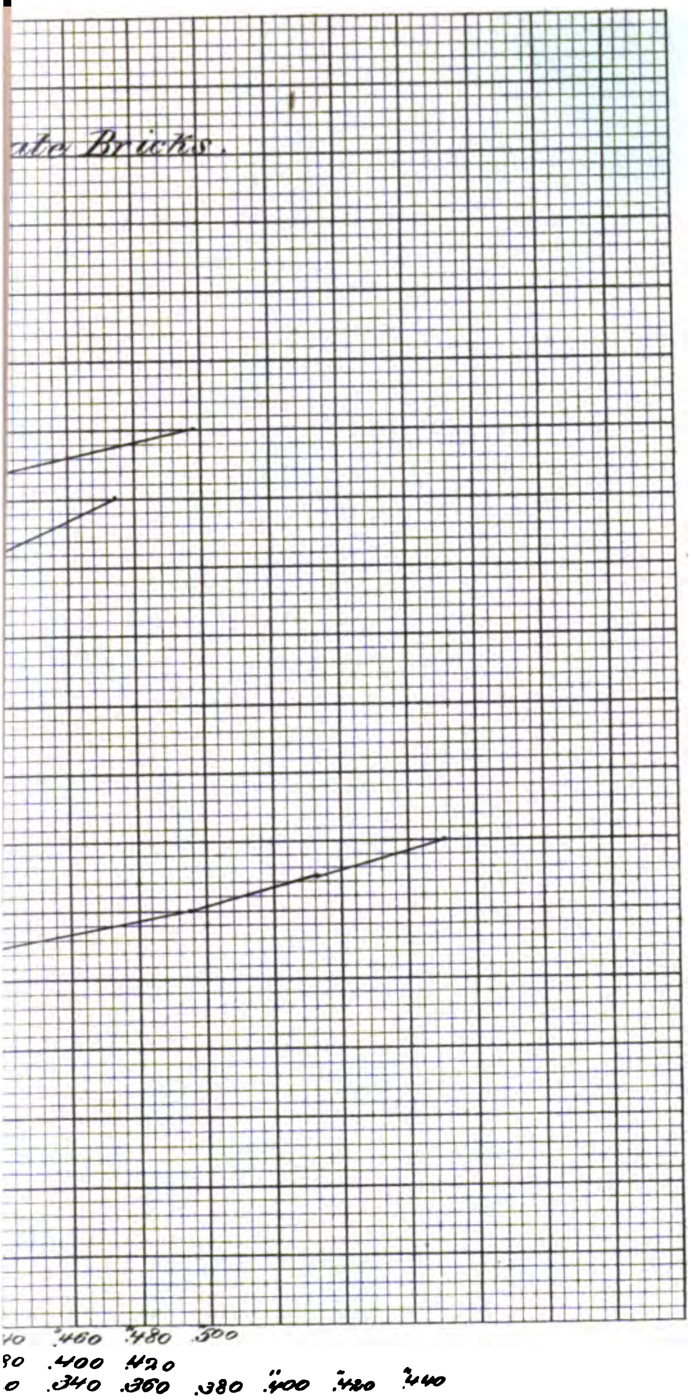

Com
Total loads, lbs.
100.000
90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10000
Initial load
0
0.
.020

S Ex 35 40 1

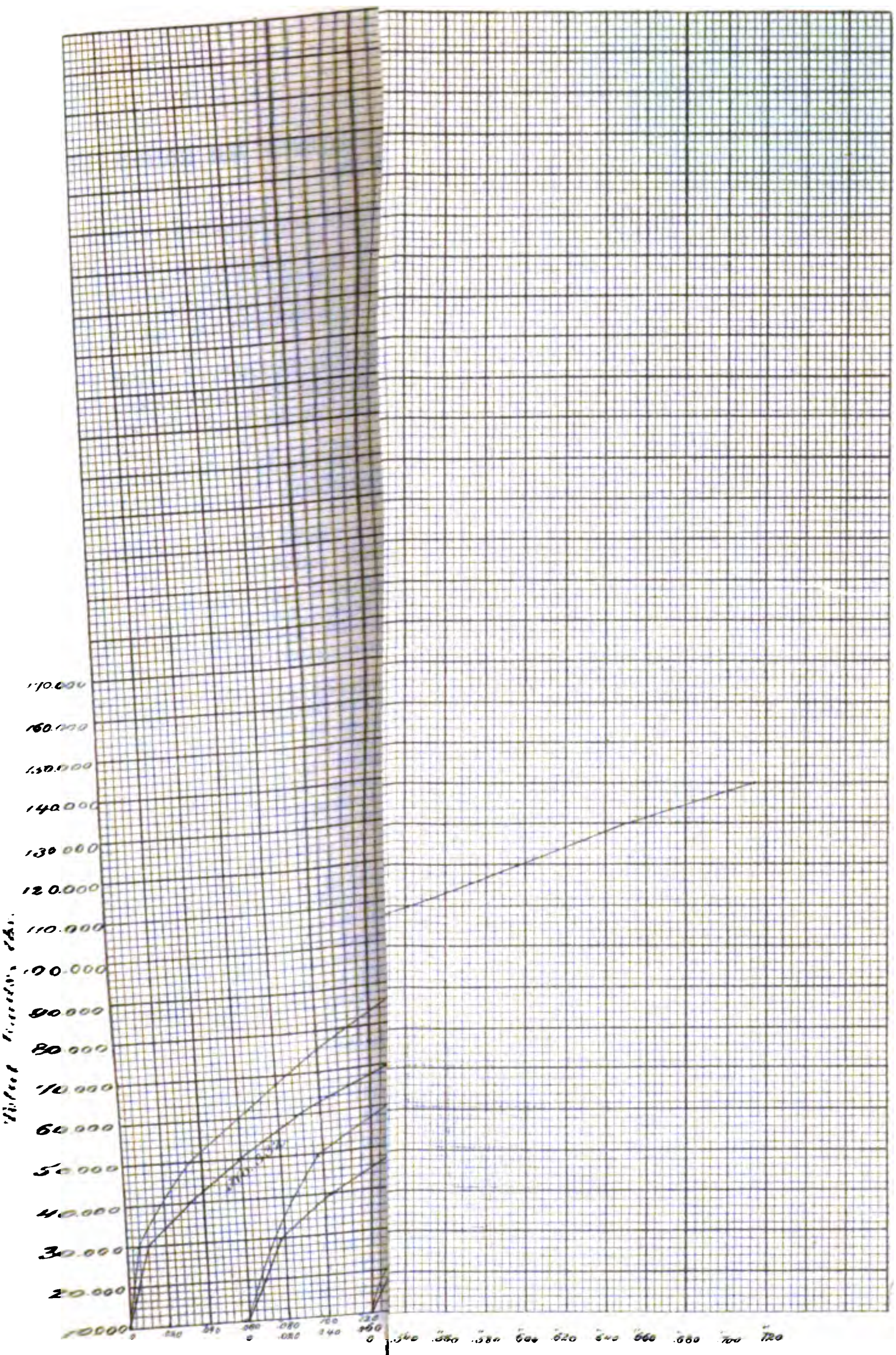

Total Loads, lbs.
130.000
120.000
110.000
100.000
90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0
.020
40
.060


nte
40
80
20
.46
.40
.34

10



11


170.000
160.000
150.000
140.000
130.000
120.000
110.000
100.000
90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0
.020
.040
.060
0
.080
.080
.100
.140
.120
.160
0
.560
.580
.580
.600
.620
.640
.660
.680
.700
.720

S Ex 25 49 1

3.—COMPRESSION OF CUBES AND PRISMS OF CEMENT, MORTARS, AND CONCRETES.

[Specimens furnished by Q. A. Gillmore, Lieutenant-Colonel Engineer Corps, U. S. Army.]

COMPRESSION OF CUBES AND PRISMS MADE OF DYCKERHOFF'S PORTLAND CEMENT, NEWARK COMPANY'S ROSENDALE CEMENT, NORTON'S CEMENT, NATIONAL PORTLAND CEMENT, ALSO HAVERSTRAW FREESTONE, KANAWHA STONE, AND BRICK PIERS.

Dyckerhoff's Portland cement was tested in neat cement cubes and prisms, in sizes from 1″ to 12″.

The other brands of cements were tested in mortar and concrete cubes, in sizes from 2″ to 18″.

The Haverstraw freestone cubes and prisms ranged from 1″ to 12″.

There were three 2″ cubes of Kanawha stone, and six 12″ brick piers 2′ high.

The preparation of the cement, mortar, and concrete blocks is thus described by J. L. Suess, assistant engineer, to Colonel Gillmore:

> The concrete blocks were made by first mixing a stiff mortar of the requisite proportions of cement and sand, and adding the broken stone of nut size, and the gravel, having if needed dampened them by sprinkling, using as little water as possible. The quantity mixed at a time was about sufficient to fill one of the largest molds, or about 2¼ cubic feet.
>
> For the mortar blocks the material was made as dry as possible and in volume sufficient to fill two of the largest molds—say about 4 cubic feet. For the smaller blocks less material was prepared at a time, there not being a sufficient number of molds.
>
> The molds were pine boxes without top or bottom, grooved together at the ends, and secured by bolts passing through the sides beyond the ends. The bottom was formed by placing the mold upon a smooth bluestone flag; the same, as well as the inside of the box, had been previously well greased to prevent adhesion.
>
> The ramming was done with an iron rammer weighing about 8 pounds. It had a conical point, and was about 2′ long and 1″ in diameter. For the smaller blocks a lighter rammer was used.
>
> The blocks were removed from the molds as soon as practicable; the small ones almost immediately and the largest within twelve hours. They were buried in sand as soon as taken from the mold as a precaution against frost, the weather being very severe. (January, 1880, and January, 1882.)
>
> The Dyckerhoff cement blocks were treated the same as the others, with the exception that they were tamped in filling the blocks. The hammer used for this purpose weighed about four pounds, and the follower was a small piece of hard wood.

MANNER OF TESTING.

The testing was done between flat steel platforms. In some cases the tests were made with the bed surfaces of the specimens in the condition they were received at the arsenal, which were good bearing surfaces, although not true planes. In other cases pine cushions were employed to effect a more even distribution of the loads, or a facing of plaster-of-paris was used. The latter method of truing the bed surfaces proved, on the whole, the most satisfactory.

The thickness of plaster recorded in the tabulation and details of the tests is the total thickness of plaster on both compressed surfaces, or the difference in height before and after facing.

Compression measurements were taken of cubes 8 inches and larger when faced with plaster-of-paris, measuring from face to face of the compression platforms.

Some of the neat cement prisms and Haverstraw freestone cubes possessed a strength, when taken singly, in excess of the capacity of the testing-machine; these were crushed in the form of piers.

CRUSHING STRENGTH OF NEAT CEMENT CUBES AND PRISMS.

[Dyckerhoff's Portland cement, Amöneburg on the Rhine, Germany.]

The age of the cement when tested was about twenty-two months.

Cubes 1″, 11″, and 12″ on a side were faced with plaster-of-paris. Intermediate sizes were tested between the steel platforms without plaster, with the exception of 2″ cube No. 18*a* and 3″ cube No. 23*a*.

All of the prisms had plastered faces.

The cubes generally failed by splitting off the sides, the remaining portions forming two pyramids or cones, their apices facing and their bases formed by the two bed surfaces. There was occasionally a tendency to develop cones with the apices overlapping each other.

The prisms failed in a similar manner by splitting off the sides, but instead of the full pyramidal development the principal fragments were truncated.

Before final fracture occurred snapping sounds were heard, and cracks were exposed to view on the sides of the specimens.

The average resistance of the different sizes of cubes and prisms are as follows:

Cubes.		Prisms.	
Nominal dimensions.	Average resistance per square inch.	Nominal dimensions.	Average resistance per square inch.
	Pounds.	*Inches.*	*Pounds.*
1-inch cube	5, 895	4×4×1	16, 460
2-inch cube	7, 053	4×4×2	6, 370
3-inch cube	5, 892	4×4×3	6, 005
4-inch cube	4, 859	....	....
5-inch cube	4, 611	8×8×2	*9, 885 10, 664
6-inch cube	4, 272		
7-inch cube	4, 987		
8-inch cube	4, 865	8×8×3	6, 168
9-inch cube	4, 745	8×8×4	5, 952
10-inch cube	4, 761	8×8×5	6, 020
11-inch cube	5, 381	8×8×6	5, 771
12-inch cube	5, 435	....	....

* Includes broken specimen.

Two of the 12″ cubes did not fracture under 800,000 pounds out of six that were tested.

The first in order of strength of the cubes are the 2″. The resistance decreases as the size increases, till the 6″ cubes are reached, which are the weakest of the series. Then the strength is advanced in the 7″ cubes and again falls off for the succeeding ones, till the 11″ cubes are reached. This latter size and the 12″ cubes have plastered ends, which probably raised their general average.

Tests 18*a* and 23*a* show such was the effect of plastered ends for the 2″ and 3″ cubes.

The 1″ cubes are anomalous in showing less resistance than the larger sizes, as they had plastered faces, and, further, the strengthening influence of the steel platforms would contribute more to their strength relatively than for the larger blocks.

The strength of the prisms is largely in favor of the shortest of the series, and abruptly changes with an increase in height from 1″ to 2″ in the 4″ × 4″ prisms, or from 2″ to 3″ in the 8″ × 8″ prisms. After this the changes of resistance are more gradual.

The 12″ × 12″ prisms were tested in the form of piers, as it was evident from the preceding tests of 12″ cubes that their strength taken singly would exceed the capacity of the testing-machine.

The 12″ × 12″ × 2″ prisms were treated as a pier, sustaining the full capacity of the testing-machine, after which, when tested with a 10″ cube of Haverstraw freestone, the combination failed under 654,000 pounds, or 6,566 pounds per square inch on the surface of the freestone.

The strengths of the other piers were as follows:

Dimensions of prisms comprising pier.	Resistance per square inch.
Inches.	*Pounds.*
12×12×4	4,585
12×12×6	4,821
12×12×8	4,496

CRUSHING STRENGTH OF NEAT CEMENT CUBES.

[Dyckerhoff's Portland cement.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.	Cushions.	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.	Remarks.
		Length.	Compressed surface.						Total.	Per square inch.		
		Inches.	*Inches.*	*Inches.*	*Sq. inches.*		*Inch.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
014	1-inch cube	1.01	1.03	.98	1.01	Steel	.01		5,710	5,653	127.0	
015	do	1.01	1.00	1.02	1.02	do	.01		6,050	5,931	126.8	One face not flat, ″.01 ± variation.
016	do	1.00	.98	1.02	1.00	do	.00½		5,900	5,900	127.4	
017	do	.98	1.02	1.02	1.04	do	.03		5,880	5,654	127.0	
018	do	1.02	1.01	1.00	1.01	do	.00+		6,120	6,059	126.8	
019	do	1.02	1.00	1.02	1.02	do	.01		6,300	6,176	127.8	
14	2-inch cube	2.03	2.02	2.03	4.10	do			33,300	8,122		
15	do	2.00	2.00	1.95	3.90	do			25,450	6,526		17,700 pounds snapping sounds.
16	do	2.00	2.00	1.99	3.98	do			24,400	6,131		
17	do	2.01	2.03	2.00	4.06	do			28,480	7,015		
18	do	2.02	2.02	1.98	3.98	do			25,100	6,306		22,100 pounds snapping sounds.
18*a*	do	2.04	1.99	2.03	4.04	do	.01	28,100	33,200	8,218		
19	3-inch cube	2.96	2.98	2.96	8.82	do		52,900	52,900	5,998		
20	do	2.97	2.95	2.98	8.79	do			47,920	5,452		
21	do	2.95	2.94	2.97	8.73	do		36,800	50,400	5,773		
22	do	2.96	2.98	2.95	8.79	do		19,000	48,400	5,506		
23	do	2.95	2.98	2.98	8.88	do		49,200	51,900	5,844		
23*a*	do	2.97	2.98	2.97	8.85	do	.00+	60,000	60,000	6,780		
24	4 inch cube	3.98	4.00	4.00	16.00	do		78,900	82,200	5,138		
25	do	4.02	4.02	4.05	16.28	do		54,800	88,500	5,436		
26	do	3.97	3.97	3.98	15.80	do			68,850	4,358		Uneven bearings. Snapping sounds at 49,000 pounds.
27	do	4.02	4.07	4.05	16.48	do			90,350	5,482		
28	do	4.02	4.02	3.99	16.04	do			74,100	4,620		
29	do	4.02	4.00	4.02	16.08	do			66,300	4,123		Snapping sounds at 35,000 pounds.
30	5-inch cube	5.01	5.02	5.02	25.20	do			104,500	4,147		At 88,700 pounds corner flaked off.
31	do	5.00	5.01	5.07	25.40	do			116,700	4,594		At 110,700 pounds snapping sounds.
32	do	5.02	5.08	5.03	25.55	do		106,800	125,900	4,928		
33	do	5.01	5.00	5.01	25.05	do		101,000	119,900	4,786		
34	do	5.00	4.90	4.92	24.11	do			121,500	5,039		
35	do	5.01	4.96	4.97	24.65	do		96,500	102,800	4,170		Corners did not take bearing.
36	6-inch cube	5.98	6.00	6.00	36.00	do			143,200	3,978		At 98,000 pounds flaked off part of one face.

	...do	[illegible]	6.00	6.00	36.00	...do		111,000	129,100	3,586		
38	...do	5.97	6.07	6.00	36.42	...do		138,100	160,300	4,401		
39	...do	5.97	6.02	6.00	36.12	...do			179,700	4,975		
40	...do	5.97	5.98	6.00	35.88	...do		130,000	135,000	3,763		
41	...do	5.98	5.98	5.99	35.82	...do		174,600	176,500	4,927		
42	7-inch cube	6.99	7.07	7.11	50.27	...do		64,000	228,900	4,553		Two corners did not take good bearings.
43	...do	7.00	7.07	7.08	50.06	...do		158,000	192,700	3,849		Did not come to full bearing at edges.
44	...do	7.05	7.09	7.14	50.62	...do			259,900	5,134		At 188,000 pounds piece came off middle of one edge.
45	...do	7.04	7.11	7.02	49.91	...do			288,200	5,774		
46	...do	7.02	7.11	7.20	51.19	...do		232,000	265,200	5,181		
47	...do	7.01	7.02	7.11	49.91	...do			271,000	5,430		
48	8-inch cube	8.00	8.00	8.05	64.40	...do		266,000	289,000	4,488		
49	...do	7.99	8.03	8.10	65.04	...do		288,000	301,100	4,629	124.8	
50	...do	8.00	8.03	8.05	64.64	...do		180,000	294,100	4,550	125.3	
51	...do	8.04	8.04	8.00	64.32	...do		350,000	360,000	5,597	129.6	
52	...do	8.02	7.98	8.03	64.08	...do		296,000	299,200	4,669	127.8	
53	...do	8.00	8.00	8.04	64.32	...do		304,000	338,000	5,255	127.6	
54	9-inch cube	9.04	9.05	9.01	81.54	...do		345,000	373,000	4,574	131.8	
55	...do	9.05	9.03	9.12	82.26	...do		327,000	373,300	4,538	129.6	
56	...do	8.99	9.00	9.00	81.00	...do		330,000	396,000	4,889	130.7	
57	...do	9.05	9.02	9.04	81.54	...do		370,000	390,000	4,783	132.3	
58	...do	9.03	9.07	9.00	81.63	...do		458,600	468,200	5,736	131.3	
59	...do	8.98	9.05	9.10	82.35	...do		130,000	325,200	3,949	129.6	
60	10-inch cube	9.97	10.08	10.05	101.30	...do		318,000	395,300	3,902	129.2	
61	...do	10.00	10.02	10.00	100.20	...do		540,000	587,100	5,859	131.9	
62	...do	10.00	10.09	10.04	101.30	...do		340,000	519,000	5,123	130.7	
63	...do	10.01	10.08	10.10	101.80	...do		300,000	430,100	4,225	130.6	
64	...do	10.00	10.00	10.05	100.50	...do		242,000	473,400	4,710	130.7	
65	...do	9.99	10.01	10.05	100.60	...do			477,600	4,747	131.6	
66	11-inch cube	11.00	11.00	11.15	122.65	...do		580,000	591,200	4,820	129.4	
67	...do	11.00	11.00	10.97	120.67	...do	.03+	570,000	633,000	5,246	130.2	
68	...do	11.00	11.00	11.18	122.98	...do	.02		725,100	5,896	129.6	
69	...do	11.00	11.03	11.21	123.65	...do	.02	528,000	674,000	5,451	128.9	
70	...do	10.99	11.02	11.21	123.53	...do	.03	680,000	690,200	5,587	128.5	
71	...do	11.02	11.05	11.05	122.10	...do	.02	630,000	645,600	5,287	128.4	
72	12-inch cube	12.00	12.05	12.00	144.60	...do	.04	660,000	710,000	4,910	128.4	
73	...do	11.97	12.08	12.05	145.56	...do	.03	673,000	783,000	5,379	128.0	
74	...do	12.03	12.00	12.03	144.36	...do	.06	700,000	800,000	5,542	129.4	
75	...do	12.00	12.00	11.30	135.60	...do	.03	708,000	800,000	5,900	130.6	
76	...do	12.00	12.05	12.00	144.60	...do	.07	770,000	800,000	5,533	130.4	
77	...do	12.00	12.00	12.06	144.72	...do	.01	685,000	773,200	5,343	129.3	

CRUSHING STRENGTH OF NEAT CEMENT PRISMS.

[Dyckerhoff's Portland cement.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.	Cushions.	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.	Remarks.
		Length.	Compressed surface.						Total.	Per square inch.		
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Sq. In.*		*Inch.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
179	4×4×1	1.03	4.03	3.98	16.04	Steel....	.01	140,000	250,000	15,586	127.6	
180	4×4×1	1.01	4.05	4.04	16.36	...do	.04	132,000	275,000	16,809	127.6	
181	4×4×1	1.02	3.98	4.06	16.19	...do	.00+	125,000	275,000	16,986	127.6	
182	4×4×2	2.00	4.01	4.02	16.12	...do	.01	91,000	102,100	6,334	125.7	Cracking sounds at 40,000 pounds.
183	4×4×2	2.03	4.05	4.01	16.24	...do	.00+	78,000	104,200	6,416	127.7	
184	4×4×2	2.02	4.06	4.02	16.32	...do	.01	89,000	103,800	6,360	127.7	
185	4×4×3	3.00	4.04	4.02	16.24	...do	.01	68,000	87,100	5,363	125.9	Double pyramid fracture.
186	4×4×3	3.02	3.99	3.99	15.92	...do	.00+	95,600	95,600	6,005	129.2	
187	4×4×3	3.02	4.02	4.02	16.16	...do	.00+	97,000	107,400	6,646	129.5	
188	8×8×2	2.02	8.07	8.07	65.12	...do	.06	283,000	654,000	10,043	128.9	
189	8×8×2	2.03	7.99	8.04	64.24	...do	.04	280,000	725,000	11,286	126.7	Cracking sound at 130,000 pounds.
190	8×8×2	2.01	8.03	8.04	64.56	.. do	.03	....	....	....	......	Accidentally broken, reduced dimensions and test immediately following.
190a	....	2.01	8.01	4.76	38.13	...do	.01	70,000	317,500	8,327	128.9	
191	8×8×3	3.00	8.15	8.04	65.53	...do	.09	313,000	379,300	5,788	126.4	
192	8×8×3	3.01	8.06	8.00	64.48	...do	.01	298,000	417,000	6,467	127.4	
193	8×8×3	3.01	8.09	8.05	65.12	...do	.06	282,000	407,000	6,250	129.2	
194	8×8×4	4.01	8.06	8.04	64.80	...do ...	.01	242,000	394,800	6,093	127.6	
195	8×8×4	4.00	8.02	8.05	64.56	...do	.03	318,000	390,600	6,050	128.9	
196	8×8×4	4.03	8.10	8.10	65.61	...do	.01	305,000	374,900	5,714	127.4	
197	8×8×5	5.09	8.00	8.02	64.16	...do	.01	421,000	421,000	6,562	129.5	
198	8×8×5	5.04	8.05	8.12	65.37	...do	.02	310,000	382,100	5,845	126.1	
199	8×8×5	5.06	8.05	8.00	64.40	...do	.01	296,000	364,000	5,652	128.6	
200	8×8×6	6.01	8.19	8.14	66.67	...do ...	.01	326,000	355,300	5,329	126.1	
201	8×8×6	6.04	8.02	8.06	64.64	...do	.02	365,800	396,100	6,128	128.1	
202	8×8×6	5.96	8.12	7.97	64.71	...do	.05	378,000	379,000	5,857	128.0	
203	12×12×2	2.05	11.95	12.03	143.76	...do	.04	....	800,000	5,565	130.8	Snapping sounds at 650,000 pounds, thought to come from plaster, otherwise apparently uninjured.
206	12×12×4	4.01	11.99	12.12	145.32	...do	.03	754,000	800,000	5,505	126.8	Edges began to flake off, not injured otherwise.

CRUSHING STRENGTH OF PIERS BUILT OF NEAT CEMENT PRISMS.

[Dyckerhoff's Portland cement.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.	Mean sectional area.	Cushions.	Thickness of plaster.	Ultimate strength.		Weight per cubic foot.	Remarks.
		Length.	Compressed surface.						Total.	Per square inch.		
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Sq. In.*	*Sq. In.*		*Inch.*	*Pounds.*	*Pounds.*	*Pounds.*	
......	12×12×2	6.20	11.95	12.03	143.76	143.68	Steel....	.08	800,000	5,568	131.12	The effect of this load on pier was the shelling off of under side of one end prism. This pier now tested with a 10″ cube of Haverstraw freestone (No. 80½).
......	12×12×2		11.95	12.03	143.76							
......	12×12×2		12.00	11.96	143.52							
80½	10×10×10	16.30	....	....	....	....	...do	.17	654,000	6,566	....	The ultimate strength in pounds per square inch is computed on the surface of the freestone cube.
	12×12×2											
	12×12×2											
	12×12×2											
79½	12×12×4	12.18	11.99	12.12	145.32	144.28	...do	.06	662,000	4,588	126.8	
	12×12×4		11.98	11.98	143.52							
	12×12×4		11.95	12.05	144.00							
77½	12×12×6	18.06	12.01	12.04	144.60	145.20	.. do	.19	709,000	4,821	129.2	
	12×12×6		12.05	11.99	144.48							
	12×12×6		12.13	12.08	146.53							
78½	12×12×8	24.40	12.03	12.14	146.04	145.64	...do	.15	654,800	4,496	126.13	
	12×12×8		11.98	12.08	144.72							
	12×12×8		12.08	12.10	146.17							

Neat cement cubes.

[Dyckerhoff's Portland cement.]

No. 49.

Length, 7″.99.
Compressed surface, 8″.03×8″.10=65.04 square inches.
Weight, 37½ pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0020		
20, 000		.0040		
30, 000		.0060		
40, 000		.0075		
50, 000		.0090		
60, 000		.0102		
70, 000		.0110		
80, 000		.0122		
90, 000		.0130		
100, 000		.0141		
5, 000			.0050	
100, 000		.0142		
120, 000		.0160		
140, 000		.0180		
160, 000		0195		
180, 000		.0210		
200, 000		.0230		
5, 000			.0070	
200, 000		.0240		
220, 000		.0255		
238, 000				First crack.
240, 000		.0280		
260, 000		.0300		
280, 000		.0330		
286, 800		.0350		
301, 100	4, 629			Ultimate strength.

No. 50.

Length, 8″.
Compressed surface, 8″.03 × 8.″05 = 64.64 square inches.
Weight, 37½ pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0020	....	
40,000	....	.0045	....	
60,000	....	.0065	....	
80,000	....	.0082	....	
100,000	....	.0100	....	
5,000	....	....	.0010	
100,000	....	.0100	....	
120,000	....	.0118	....	
140,000	....	.0133	....	
160,000	....	.0150	....	
180,000	....	.0166	....	
200,000	....	.0182	....	
5,000	....	....	.0025	
180,000	....	....	....	Corner cracked.
200,000	....	.0190	....	
220,000	....	.0207	....	
240,000	....	.0227	....	
260,000	....	.0250	....	
280,000	....	.0282	....	
285,000	....	.0296	....	
289,900	....	....	....	Rapid yielding and splitting up of cube.
294,100	4,550	....	....	Ultimate strength.

No. 51.

Length, 8″.04.
Compressed surface, 8″.04 × 8″ = 64.32 square inches.
Weight, 39 pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0005		
20,000		.0020		
40,000		.0040		
60,000		.0062		
80,000		.0077		
100,000		.0090		
5,000			.0010	
100,000		.0092		
120,000		.0105		
140,000		.0120		
160,000		.0130		
180,000		.0145		
200,000		.0160		
5,000			.0020	
200,000		.0160		
220,000		.0175		
240,000		.0190		
260,000		.0203		
280,000		.0223		
285,000		.0230		
290,000		.0239		
295,000		.0244		
300,000		.0250		
305,000		.0255		
310,000		.0260		
315,000		.0264		
320,000		.0270		
325,000		.0280		
330,000		.0288		
335,000		.0292		
340,000		.0300		
345,000		.0305		
350,000		.0310		Begins to shell off.
355,000		.0323		
358,000		.0335		
360,000	5,597			Ultimate strength.

No. 52.

Length, 8''.02.
Compressed surface, 7''.98 × 8''.03 = 64.08 square inches.
Weight, 38 pounds.

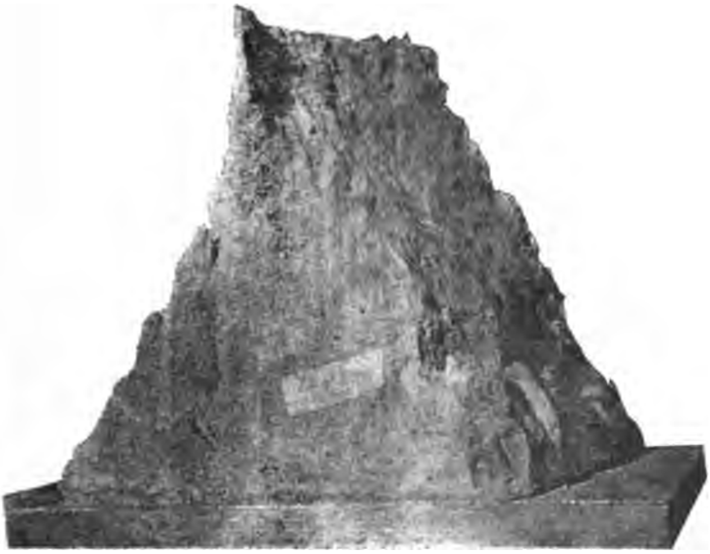
Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0025	....	
40,000	....	.0048	....	
60,000	....	.0065	....	
80,000	....	.0080	....	
100,000	....	.0099	....	
5,000	....	....	.0015	
100,000	....	.0100	....	
120,000	....	.0114	....	
140,000	....	.0130	....	
160,000	....	.0144	....	
180,000	....	.0160	....	
200,000	....	.0178	....	
5,000	....	....	.0027	
200,000	....	.0180	....	
220,000	....	.0193	....	
240,000	....	.0218	....	
260,000	....	.0239	....	
280,000	....	.0262	....	
296,000	....	.0218	....	Cracks at one corner.
299,200	4,669	....	....	Ultimate strength.

No. 55.

Length, 9″.05.
Compressed surface, 9″.02×9″.12=82.26 square inches.
Weight, 56 pounds.
Compression faces not flat; ″.00½ convex.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0017	....	
20,000	....	.0038	....	
40,000	....	.0072	....	
60,000	....	.0102	....	
80,000	....	.0125	....	
100,000	....	.0145	....	
5,000	....	....	.0020	
100,000	....	.0150	....	
140,000	....	.0181	....	
180,000	....	.0210	....	
200,000	....	.0222	....	
5,000	....	....	.0030	
200,000	....	.0224	....	
240,000	....	.0245	....	
280,000	....	.0270	....	
300,000	....	.0280	....	
5,000	....	....	.0043	
300,000	....	.0282	....	
320,000	....	.0295	....	
327,000	....	....	....	Corner cracked off.
330,000	....	.0302	....	
340,000	....	.0309	....	
350,000	....	.0315	....	
360,000	....	.0320	....	Fragments continued to fly off.
373,300	4,538	....	....	Ultimate strength.

PHOTOGRAPH OF PYRAMID, FROM CUBE OF NEAT CEMENT
No. 56, AFTER THE TEST.



No. 56.

Length, 8″.99.
Compressed surface, 9″.00×9″.00=81.00 square inches.
Weight, 55 pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0012	....	
20, 000	....	.0035	....	
40, 000	....	.0063	....	
60, 000	....	.0082	....	
80, 000	....	.0100	....	
100, 000	....	.0117	....	
5, 000	....	....	.0015	
100, 000	....	.0120	....	
140, 000	....	.0150	....	
180, 000	....	.0177	....	
200, 000	....	.0190	....	
5, 000	....	....	.0030	
200, 000	....	.0191	....	
240, 000	....	.0215	....	
280, 000	....	.0243	....	
300, 000	....	.0259	....	
5, 000	....	....	.0050	
300, 000	....	.0262	....	
330, 000	....	.0285	....	Corner cracked off.
350, 000	....	.0330	....	
395, 400	....	....	....	Sudden yielding.
396, 000	4, 889	....	....	Ultimate strength.

No. 57.

Length, 9″.05.
Compressed surface, 9″.02×9″.04=81.54 square inches.
Weight, 56½ pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0005	....	
20, 000	....	.0011	....	
40, 000	....	.0030	....	
60, 000	....	.0041	....	
80, 000	....	.0055	....	
100, 000	....	.0070	....	
5, 000	....	....	.0010	
100, 000	....	.0071	....	
140, 000	....	.0094	....	
180, 000	....	.0120	....	
200, 000	....	.0132	....	
5, 000	....	....	.0015	
200, 000	....	.0135	....	
240, 000	....	.0160	....	
280, 000	....	.0182	....	
300, 000	....	.0202	....	
5, 000	....	....	.0030	
300, 000	....	.0210	....	
340, 000	....	.0240	....	
370, 000	....	.0278	....	Cracks in sight.
380, 000	....	.0288	....	
390, 000	4, 783	.0295	....	Ultimate strength.

Burst into fragments suddenly under the maximum load.

No. 58.

Length, 9″.03.
Compressed surface, 9″.07 × 9″.00 = 81.63 square inches.
Weight, 56 pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0020		
20,000		.0030		
40,000		.0052		
60,000		.0070		
80,000		.0081		
100,000		.0095		
5,000			.0020	
100,000		.0096		
140,000		.0120		
180,000		.0142	?	
200,000		.0155		
5,000			.0030	
200,000		.0155		
240,000		.0178		
280,000		.0200		
300,000		.0212		
5,000			.0040	
300,000		.0215		
340,000		.0240		
370,000		.0260		
380,000		.0270		
390,000		.0275		
400,000		.0284		
458,600				Began to crack.
468,200	5,736			Ultimate strength.

No. 59.

Length, 8″.98.
Compressed surface, 9″.05 × 9″.10 = 82.35 square inches.
Weight, 55½ pounds.
Compression faces convex, 0″.00½.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0010		
20,000		.0030		
40,000		.0052		
60,000		.0071		
80,000		.0090		
100,000		.0108		
5,000			.0020	
100,000		.0110		Cracked at 130,000 pounds.
140,000		.0142		
180,000		.0172		
200,000		.0190		
5,000			.0045	
200,000		.0192		
240,000		.0220		
280,000		.0258		
300,000		.0282		
5,000			.0081	
300,000		.0308		
310,000		.0328		
325,200	3,949			Ultimate strength.

No. 60.

Length, 9''.97.
Compressed surface, 10''.08 × 10''.05=101.30 square inches.
Weight, 75½ pounds.
One compression face convex, ''.01.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0018	....	
20, 000	....	.0040	....	
40, 000	....	.0070	....	
60, 000	....	.0090	....	
80, 000	....	.0110	....	
100, 000	....	.0120	....	
5, 000	....	....	.0022	
100, 000	....	.0120	....	
140, 000	....	.0145	....	
180, 000	....	.0170	....	
200, 000	....	.0180	....	
5, 000	....	....	.0040	
200, 000	....	.0180	....	
240, 000	....	.0200	....	
280, 000	....	.0221	....	
300, 000	....	.0235	....	
5, 000	....	....	.0060	
300, 000	....	.0238	....	
318, 000	....	....	....	Cracked.
320, 000	....	.0253	....	
340, 000	....	.0267	....	
357, 000	....	.0292	....	
395, 300	3, 902	....	....	Ultimate strength.

No. 61.

Length, 10″.00.
Compressed surface, 10″.02×10″.00=100.20 square inches.
Weight, 76½ pounds.
Good bearings.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0003	....	
20, 000	....	.0010	....	
40, 000	....	.0022	....	
60, 000	....	.0031	....	
80, 000	....	.0040	....	
100, 000	....	.0050	....	
5, 000	....	....	.0010	
100, 000	....	.0052	....	
140, 000	....	.0072	....	
180, 000	....	.0088	....	
200, 000	....	.0098	....	
5, 000	....	....	.0010	
200, 000	....	.0099	....	
240, 000	....	.0115	....	
280, 000	....	.0132	....	
300, 000	....	.0145	....	
5, 000	....	....	.0015	
300, 000	....	.0145	....	
340, 000	....	.0160	....	
380, 000	....	.0180	....	
400, 000	....	.0192	....	
5, 000	....	....	.0020	
400, 000	....	.0192	....	
440, 000	....	.0218	....	
460, 000	....	.0230	....	
470, 000	....	.0240	....	
480, 000	....	.0250	....	
540, 000	....	....	....	Cement cracked.
587, 100	5, 859	....	....	Ultimate strength.

No. 62.

Length, 10″.00.
Compressed surface, 10″.09×10″.04=101.30 square inches.
Weight, 76½ pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0008	....	
20,000	....	.0042	....	
40,000	....	.0075	....	
60,000	....	.0100	....	
80,000	....	.0115	....	
100,000	....	.0128	....	
5,000	....	....	.0025	
100,000	....	.0128	....	
140,000	....	.0148	....	
180,000	....	.0165	....	
200,000	....	.0174	....	
5,000	....	....	.0035	
200,000	....	.0175	....	
240,000	....	.0190	....	
280,000	....	.0210	....	
300,000	....	.0220	....	
5,000	....	....	.0048	
300,000	....	.0220	....	
340,000	....	.0240	....	One edge shelled off.
380,000	....	.0260	....	
400,000	....	.0270	....	
5,000	....	....	.0071	
400,000	....	.0275	....	
440,000	....	.0288	....	
460,000	....	.0308	....	
519,000	5,123	....	....	Ultimate strength.

No. 63.

Length, 10″.01.
Compressed surface, 10″.08×10″.10=101.80 square inches.
Weight, 77 pounds.
One face ″.00½ convex.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0012	....	
20,000	....	.0030	....	
40,000	....	.0062	....	
60,000	....	.0084	....	
80,000	....	.0103	....	
100,000	....	.0120	....	
5,000	....	....	.0010	
100,000	....	.0120	....	
140,000	....	.0148	....	
180,000	....	.0168	....	
200,000	....	.0180	....	
5,000	....	....	.0020	
200,000	....	.0182	....	
240,000	....	.0202	....	
280,000	....	.0225	....	
300,000	....	.0238	....	
5,000	....	....	.0041	
300,000	....	.0252	....	Longitudinal crack in sight.
320,000	....	.0273	....	
430,100	4,225	....	....	Ultimate strength.

No. 64.

Length, 10''.00.
Compressed surface, 10''.00 × 10''.05 = 100.50 square inches.
Weight, 76 pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0008		
20,000		.0020		
40,000		.0042		
60,000		.0062		
80,000		.0075		
100,000		.0090		
5,000			.0010	
100,000		.0090		
140,000		.0116		
180,000		.0140		
200,000		.0150		
5,000			.0020	
200,000		.0150		
240,000		.0172		
242,000				Cracked lower surface.
280,000		.0202		
300,000		.0218		
5,000			.0032	
300,000		.0220		
340,000		.0242		
380,000		.0272		
400,000		.0290		
5,000			.0060	
400,000		.0300		
473,400	4,710			Ultimate strength.

No. 65.

Length, 9''.99.
Compressed surface, 10''.01 × 10''.05 = 100.60 square inches.
Weight, 76½ pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0020	....	
40,000	....	.0040	....	
60,000	....	.0053	....	
80,000	....	.0065	....	
100,000	....	.0078	....	
5,000	....	....	.0010	
100,000	....	.0080	....	
140,000	....	.0102	....	
180,000	....	.0120	....	
200,000	....	.0140	....	
5,000	....	....	.0015	
200,000	....	.0140	....	
240,000	....	.0160	....	
280,000	....	.0180	....	
300,000	....	.0198	....	
5,000	....	....	.0025	
300,000	....	.0198	....	
340,000	....	.0220	....	
380,000	....	.0245	....	
400,000	....	.0260	....	
5,000	....	....	.0042	
400,000	....	.0265	....	
420,000	....	.0280	....	
440,000	....	.0290	....	
460,000	....	.0304	....	
472,000	....	.0320	....	
477,600	4,747	....	....	Ultimate strength.

No. 66.

Length, 11''.00.
Compressed surface, 11''.00 × 11''.15 = 122.65 square inches.
Weight, 101 pounds.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0005	....	
20,000	....	.0020	....	
40,000	....	.0035	....	
60,000	....	.0048	....	
80,000	....	.0060	....	
100,000	....	.0070	....	
5,000	....	....	.0008	
100,000	....	.0070	....	
140,000	....	.0092	....	
180,000	....	.0110	....	
200,000	....	.0120	....	
5,000	....	....	.0012	
200,000	....	.0122	....	
240,000	....	.0141	....	
280,000	....	.0160	....	
300,000	....	.0175	....	
5,000	....	....	.0020	
300,000	....	.0175	....	
340,000	....	.0200	....	
380,000	....	.0220	....	
400,000	....	.0235	....	
5,000	....	....	.0032	
400,000	....	.0240	....	
440,000	....	.0260	....	
480,000	....	.0290	....	
500,000	....	.0302	....	
5,000	....	....	.0052	
500,000	....	.0313	....	
510,000	....	.0324	....	
520,000	....	.0332	....	
530,000	....	.0340	....	Cement cracked.
540,000	....	.0350	....	
591,200	4,820	....	....	Ultimate strength.

No. 67.

Length, 11″.00.
Compressed surface, 11″.00×10″.97=120.67 square inches.
Weight, 100 pounds.
Total thickness of plaster, ″.03.

This and the following cubes were plastered on compressed surfaces.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0008		
20,000		.0022		
40,000		.0042		
80,000		.0065		
100,000		.0078		
5,000			.0020	
100,000		.0078		
140,000		.0090		
180,000		.0110		
200,000		.0120		
5,000			.0031	
200,000		.0120		
240,000		.0138		
280,000		.0155		
300,000		.0165		
5,000			.0040	
300,000		.0168		
340,000		.0188		
380,000		.0210		
400,000		.0220		
5,000			.0058	
400,000		.0222		
440,000		.0248		
480,000		.0270		
500,000		.0288		
5,000			.0078	
500,000		.0292		
510,000		.0302		
520,000		.0312		
530,000		.0320		
540,000		.0325		
550,000		.0330		
560,000		.0335		
570,000		.0350		Corners cracked.
580,000		.0358		
590,000		.0370		
600,000		.0379		
610,000		.0390		
620,000		.0402		
630,000		.0415		
633,000	5,246	.0430		Ultimate strength.

No. 68.

Length, 11″.00.
Compressed surface, 11″.00 × 11″.18 = 122.98 square inches.
Weight, 101½ pounds.
Total thickness of plaster, ″.02.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0005		
20,000		.0015		
40,000		.0030		
80,000		.0050		
100,000		.0062		
5,000			.0010	
100,000		.0062		
200,000		.0112		
5,000			.0019	
200,000		.0110		
300,000		.0160		
5,000			.0025	
300,000		.0162		
400,000		.0220		
5,000			.0037	
400,000		.0225		
500,000		.0285		
5,000			.0050	
500,000		.0290		
520,000		.0302		
540,000		.0320		
560,000		.0332		
570,000		.0342		
580,000		.0352		
590,000		.0362		
600,000		.0372		
610,000		.0380		
620,000		.0387		
630,000		.0395		
640,000		.0405		
650,000		.0422		
660,000		.0428		
670,000		.0440		
680,000		.0460		
690,000		.0470		
700,000		.0480		
725,100	5,896			Ultimate strength.

No. 69.

Length, 11".00.
Compressed surface, 11".03×11".21=123.65 square inches.
Weight, 101½ pounds.
Total thickness of plaster, ".02.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0002	....	
20,000	....	.0010	....	
40,000	....	.0020	....	
80,000	....	.0040	....	
100,000	....	.0048	....	
5,000	....	....	.0010	
100,000	....	.0050	....	
200,000	....	.0090	....	
5,000	....	....	.0018	
200,000	....	.0090	....	
300,000	....	.0135	....	
5,000	....	....	.0020	
300,000	....	.0138	....	
400,000	....	.0182	....	
5,000	....	....	.0030	
400,000	....	.0186	....	
500,000	....	.0240	....	
5,000	....	....	.0040	
500,000	....	.0250	....	
520,000	....	.0250	....	Cracks at 528,000 pounds pressure.
530,000	....	.0272	....	
540,000	....	.0282	....	
550,000	....	.0290	....	
560,000	....	.0292	....	
570,000	....	.0300	....	
580,000	....	.0308	....	
590,000	....	.0315	....	
600,000	....	.0320	....	
620,000	....	.0340	....	
640,000	....	.0365	....	
660,000	....	.0390	....	
674,000	5,451	.0415	....	Ultimate strength.

No. 70.

Length, 10''.99.
Compressed surface, 11''.02 × 11''.21 = 123.53 square inches.
Weight, 101 pounds.
Total thickness of plaster, ''.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0008	....	
20,000	....	.0018	....	
40,000	....	.0028	....	
80,000	....	.0045	....	
100,000	....	.0052	....	
5,000	....	....	.0010	
100,000	....	.0060	....	
200,000	....	.0095	....	
5,000	....	....	.0018	
200,000	....	.0097	....	
300,000	....	.0140	....	
5,000	....	....	.0025	
300,000	....	.0140	....	
400,000	....	.0190	....	
5,000	....	....	.0032	
400,000	....	.0190	....	
500,000	....	.0250	....	
5,000	....	....	.0049	
500,000	....	.0268	....	
510,000	....	.0278	....	
520,000	....	.0282	....	
540,000	....	.0292	....	
560,000	....	.0310	....	
580,000	....	.0325	....	
600,000	....	.0340	....	
620,000	....	.0360	....	
640,000	....	.0382	....	
660,000	....	.0408	....	
680,000	....	.0432	....	Cracks in sight.
690,200	5,587	.0470	....	Ultimate strength.

No. 71.

Length, 11''.02.
Compressed surface, 11''.05 × 11''.05 = 122.10 square inches.
Weight, 100 pounds.
Total thickness of plaster, ''.02.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0008		
20, 000		.0019		
40, 000		.0035		
80, 000		.0058		
100, 000		.0069		
5, 000			.0020	
100, 000		.0060		
200, 000		.0110		
5, 000			.0028	
200, 000		.0112		
300, 000		.0160		
5, 000			.0038	
300, 000		.0160		
400, 000		.0210		
5, 000			.0050	
400, 000		.0212		
500, 000		.0270		
5, 000			.0069	
500, 000		.0280		
520, 000		.0290		
540, 000		.0300		
560, 000		.0315		
580, 000		.0330		
600, 000		.0350		
620, 000		.0372		
630, 000		.0390		Cracks in sight.
640, 000		.0410		
645, 600	5, 287	.0422		Ultimate strength.

No. 72.

Length, 12″.00.
Compressed surface, 12″.05×12″.00=144.60 square inches.
Weight, 129 pounds.
Total thickness of plaster, ″.04.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0022	....	
80,000	....	.0040	....	
100,000	....	.0048	....	
5,000	....	....	.0010	
100,000	....	.0048	....	
200,000	....	.0088	....	
5,000	....	....	.0020	
200,000	....	.0090	....	
300,000	....	.0132	....	
5,000	....	....	.0028	
300,000	....	.0135	....	
400,000	....	.0182	....	
5,000	....	....	.0038	
400,000	....	.0182	....	
500,000	....	.0240	....	
5,000	....	....	.0050	
500,000	....	.0248	....	
600,000	....	.0320	....	
5,000	....	....	.0080	
600,000	....	.0330	....	
620,000	....	.0352	....	
640,000	....	.0370	....	
660,000	....	.0390	....	Cracks in sight.
680,000	....	.0422	....	
690,000	....	.0450	....	
700,000	....	.0475	....	
710,000	4,910	.0520	....	Ultimate strength.

No. 73.

Length, 11″.97.
Compressed surface, 12″.08×12″.05=145.56 square inches.
Weight, 129 pounds.
Total thickness of plaster, ″.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0039	....	
80,000	....	.0060	....	
100,000	....	.0070	....	
5,000	....	....	.0017	
100,000	....	....	....	
200,000	....	.0115	....	
5,000	....	....	.0022	
300,000	....	.0159	....	
5,000	....	....	.0030	
400,000	....	.0200	....	
5,000	....	....	.0039	
500,000	....	.0260	....	
5,000	....	....	.0050	
600,000	....	.0320	....	
5,000	....	....	.0070	
600,000	....	.0330	....	
640,000	....	.0365	....	
673,000	....	.0402	....	Cracks in sight.
783,000	5,379	....	....	Ultimate strength.

No. 74.

Length, 12″.03.
Compressed surface, 12″ × 12″.03 = 144.36 square inches.
Weight, 130 pounds.
Total thickness of plaster, ″.06.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0030	....	
80,000	....	.0049	....	
100,000	....	.0058	....	
5,000	....	....	.0022	
200,000	....	.0100	....	
5,000	....	....	.0030	
300,000	....	.0140	....	
5.000	....	....	.0035	
400,000	....	.0180	....	
5.000	....	....	.0040	
500,000	....	.0220	....	
5,000	....	....	.0050	
600,000	....	.0270	....	
5,000	....	....	.0060	
600,000	....	.0280	....	
640,000	....	.0300	....	
660,000	....	.0315	....	
680,000	....	.0330	....	
700,000	....	.0345	....	Cracks in sight.
710,000	....	.0352	....	
720,000	....	.0365	....	
730,000	....	.0372	....	
740,000	....	.0382	....	
750,000	....	.0390	....	
760,000	....	.0400	....	
800,000	5,542	....	....	
5,000	....	....	....	

800,000 pounds applied four times, returning to 5,000 pounds after each loading; then the pressure was allowed to remain at its maximum eight minutes, after which it was released to 5,000 pounds. The sixth loading caused rapid failure under 800,000 pounds pressure.

No. 75.

Length, 12″.
Compressed surface, 12″ × 11″.30=135.60 square inches.
Weight, 123 pounds.
Total thickness of plaster, ″.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
40,000		.0025		
80,000		.0042		
100,000		.0053		
5,000			.0030	
200,000		.0100		
5,000			.0040	
300,000		.0140		
5,000			.0045	
400,000		.0180		
5,000			.0052	
500,000		.0232		
5,000			.0065	
600,000		.0300		
5,000			.0090	
600,000		.0306		
620,000		.0322		
640,000		.0338		
660,000		.0352		
680,000		.0370		
700,000		.0385		
708,000				Cracks in sight.
710,000		.0392		
720,000		.0405		
730,000		.0414		
740,000		.0422		
750,000		.0437		
760,000		.0450		
770,000		.0458		
780,000		.0468		
790,000		.0475		
798,000		.0488		Small pieces flew off.
800,000	5,900			
5,000				

The maximum load, 800,000 pounds, applied four times, returning to the initial load, 5,000 pounds, between each repetition. The pressure was then applied for the fifth time, and maintained at 800,000 pounds, for a period of six minutes, when the cube rapidly failed.

Each application of 800,000 pounds caused small pieces to fly off and increased the size of the cracks.

No. 76.

Length, 12″.
Compressed surface, 12″.05 × 12″ = 144.60 square inches.
Weight, 131 pounds.
Total thickness of plaster, .07″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
40,000		.0025		
80,000		.0042		
100,000		.0050		
5,000			0.	
200,000		.0085		
5,000			.0010	
300,000		.0125		
5,000			.0020	
400,000		.0170		
5,000			.0032	
500,000		.0220		
5,000			.0050	
600,000		.0275		
5,000			.0070	
600,000		.0285		
620,000		.0302		
640,000		.0318		
660,000		.0330		
680,000		.0345		
700,000		.0357		
720,000		.0370		
740,000		.0383		
760,000		.0400		
770,000				Pieces flew off.
780,000		.0420		
800,000		.0445		
5,000			.0137	
100,000		.0175		
5,000			.0132	
200,000		.0215		
5,000			.0132	
300,000		.0250		
5,000			.0132	
400,000		.0290		
5,000			.0132	
500,000		.0325		
5,000			.0133	
600,000		.0365		
5,000			.0135	
700,000		.0410		
5,000			.0140	
770,000				Pieces flew off.
800,000	5,533			Ultimate strength.

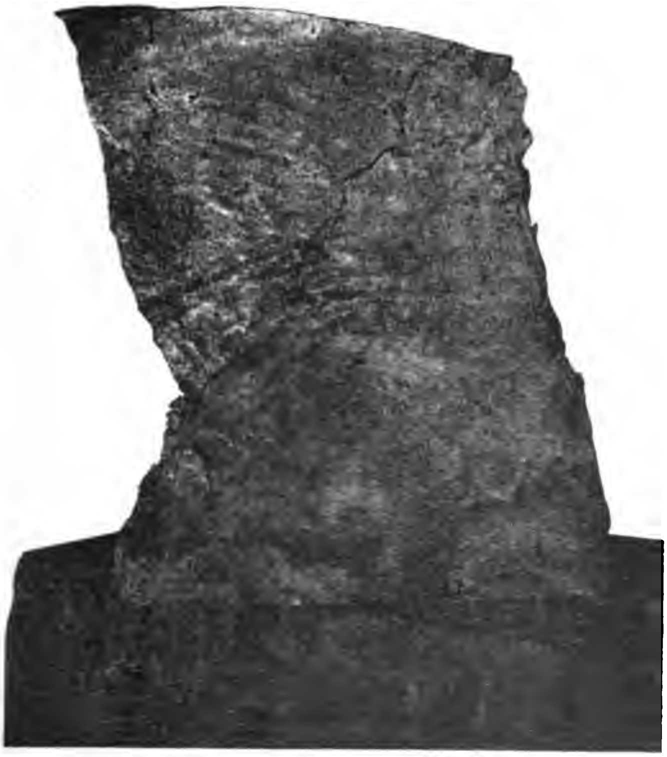
Sustained 800,000 pounds one half minute; then failed rapidly.

No. 77.

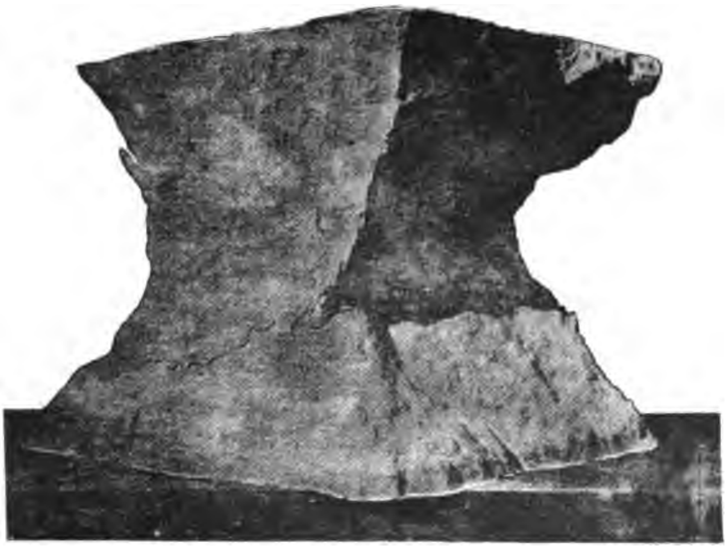
Length, 12″.
Compressed surface, 12″×12″.06=144.72 square inches.
Weight, 130 pounds.
Total thickness of plaster, .01″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
40, 000		.0030		
80, 000		.0050		
100, 000		.0060		
5, 000			.0020	
200, 000		.0100		
5, 000			.0030	
300, 000		.0142		
5, 000			.0040	
400, 000		.0185		
5, 000			.0050	
500, 000		.0240		
5, 000			.0065	
600, 000		.0302		
5, 000			.0085	
620, 000		.0328		
640, 000		.0340		
660, 000		.0355		
680, 000		.0372		
685, 000				Pieces flew off.
700, 000		.0410		
715, 500				Decided yielding; fragment disturbed measuring instrument.
773, 200	5, 343			Ultimate strength.

PHOTOGRAPH OF NEAT CEMENT CUBE No. 46, AFTER THE TEST, SHOWING THE DEVELOPMENT OF TWO PYRAMIDS OVERLAPPING.



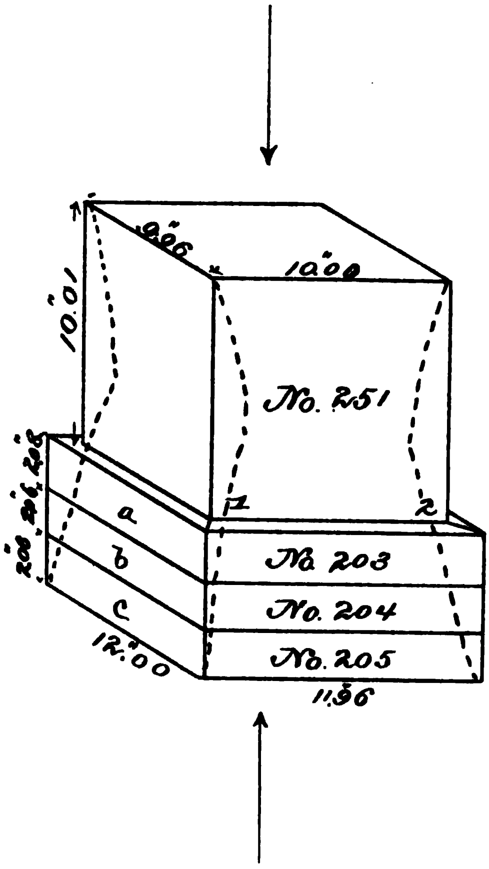
PHOTOGRAPH OF NEAT CEMENT PRISM No. 200, AFTER THE TEST, SHOWING DEVELOPMENT OF TWO TRUNCATED PYRAMIDS.



S. Ex. 35, 49, 1.

PIERS BUILT OF NEAT CEMENT PRISMS.

No. 80½



S Ex 35 49 1

No. 80½.

Test of a pier built of three 12-inch neat cement prisms (Nos. 203, 204, and 205) and one Haverstraw freestone cube (No. 251).

Under 550,000 pounds pressure, cracking sounds were heard.

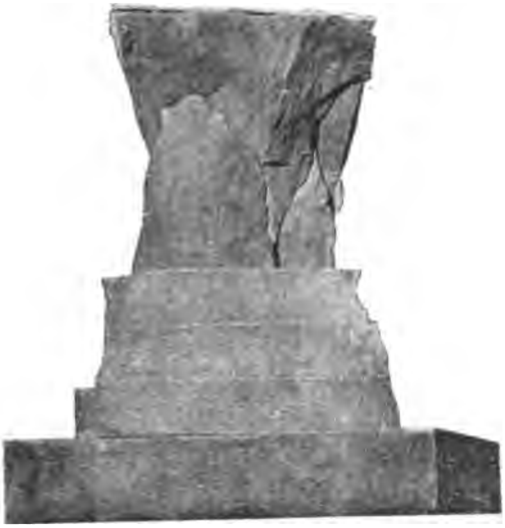
At 580,000 pounds, prism *c* began to flake off at corner.

At 627,000 pounds, fractures opened in the two corners of the cement prism, 1 and 2.

Ultimate strength, 654,000 pounds.

The pier failed with a loud report, the sides flying off in small pieces, the remaining portions forming two truncated pyramids, indicated by the dotted lines of the sketch, and shown by the heliotype.

PHOTOGRAPH OF PIER No. 80½, AFTER THE TEST.



No. 79½.

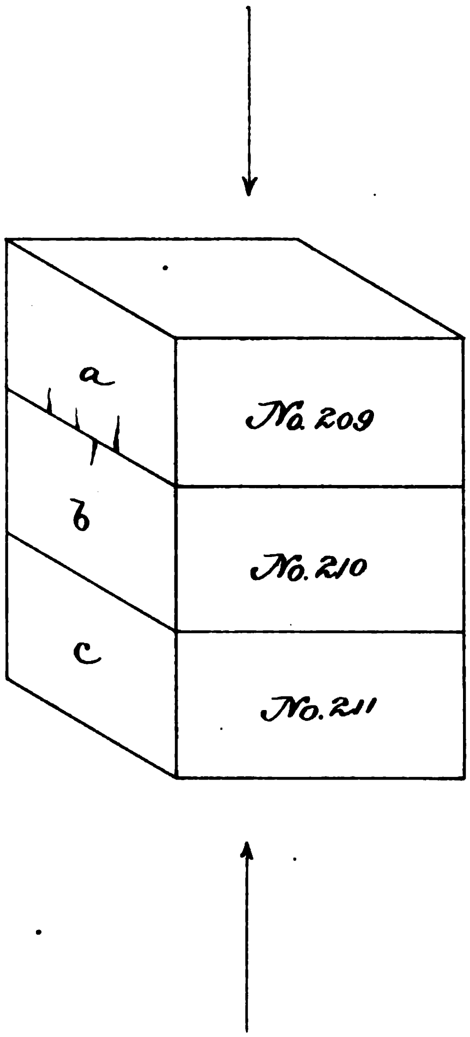
Test of a pier built of three neat cement prisms, each 12″×12″×4″ (Nos. 206, 207, and 208).

Total height of pier, 12″.18.

Sectional area, 144.28 square inches.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0030	....	
80,000	....	.0060	....	
100,000	....	.0072	....	
5,000	....	....	.0020	
100,000	....	.0072	....	
200,000	....	.0130	....	
5,000	....	....	.0040	
200,000	....	.0135	....	
300,000	....	.0200	....	
5,000	....	....	.0070	
300,000	....	.0200	....	
400,000	....	.0272	....	
5,000	....	....	.0100	
400,000	....	.0280	....	
500,000	....	.0360	....	
5,000	....	......	.0130	
500,000	....	.0362	....	
590,000	....	.0450	....	Cracked each prism.
600,000	....	.0462	....	
5,000	....	....	.0180	
600,000	....	.0480	....	
662,000	4,588	....	....	Ultimate strength.

No. 77½



No. 77½.

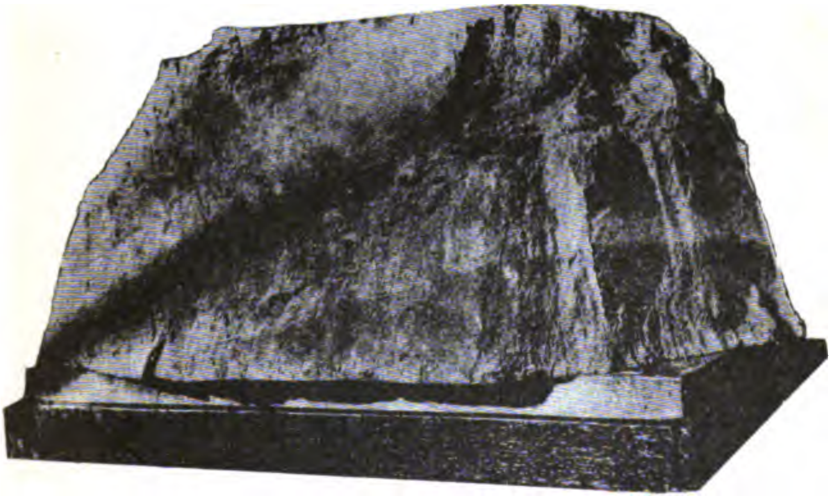
Test of a pier built of three neat cement prisms, each 12″×12″×6. (Nos. 209, 210, and 211.)

Total height of pier, 18″.06.

Sectional area, 145.20 square inches.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0015	....	
20, 000	....	.0030	....	
40, 000	....	.0055	....	
60, 000	....	.0072	....	
80, 000	....	.0088	....	
100, 000	....	.0101	....	
5, 000	....	....	.0039	
100, 000	....	.0102	....	
120, 000	....	.0120	....	
140, 000	....	.0130	....	
160, 000	....	.0148	....	
180, 000	....	.0160	....	
200, 000	....	.0175	....	
5, 000	....	....	.0062	
200, 000	....	.0178	....	
220, 000	....	.0190	....	
240, 000	....	.0201	....	
260, 000	....	.0220	....	
280, 000	....	.0232	....	
300, 000	....	.0252	....	
5, 000	....	....	.0091	
300, 000	....	.0252	....	
320, 000	....	.0270	....	
340, 000	....	.0290	....	
360, 000	....	.0310	....	
380, 000	....	.0335	....	
400, 000	....	.0360	....	
5, 000	....	....	.0147	
400, 000	....	.0360	....	
420, 000	....	.0389	....	
440, 000	....	.0412	....	
460, 000	....	.0445	....	
480, 000	....	.0475	....	
500, 000	....	.0498	....	
5, 000	....	....	.0222	
500, 000	....	.0512	....	
520, 000	....	.0540	....	
540, 000	....	.0565	....	
560, 000	....	.0590	....	
580, 000	....	.0628	....	
600, 000	....	.0660	....	
5, 000	....	....	.0322	
600, 000	....	.0678	....	
620, 000	....	.0700	....	
640, 000	....	.0730	....	
660, 000	....	.0765	....	Snapping sound.
680, 000	....	.0800	....	
700, 000	4, 821	.0840	....	Ultimate strength; cracks opened at joint of *a* and *b*.
5, 000	....	....	.0420	
690, 000	....	....	....	Highest load sustained after determining last set.

PHOTOGRAPH OF NEAT CEMENT PRISM No. 211, (TESTED IN PIER No. 77½,) AFTER THE TEST.



No. 78½.

Test of a pier built of three neat cement prisms, each 12″×12″×8. (Nos. 212, 213, and 214.)
Total height of pier, 24″.40.
Sectional area, 145.64 square inches.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0012		
20, 000		.0032		
40, 000		.0071		
60, 000		.0096		
80, 000		.0114		
100, 000		.0130		
5, 000			.0042	
100, 000		.0132		
120, 000		.0149		
140, 000		.0162		
160, 000		.0180		
180, 000		.0200		
200, 900		.0215		
5, 000			.0062	
200, 000		.0217		
220, 000		.0232		
240, 000		.0250		
260, 000		.0267		
280, 000		.0282		
300, 000		.0300		
5, 000			.0088	
300, 000		.0302		
320, 000		.0320		
340, 000		.0340		
360, 000		.0360		
380, 000		.0380		
400, 000		.0400		
5, 000			.0120	
400, 000		.0402		
420, 000		.0425		
440, 000		.0448		
460, 000		.0471		
480, 000		.0500		
500, 000		.0520		
5, 000			.0162	
500, 000		.0530		
520, 000		.0560		
540, 000		.0590		
560, 000		.0615		
580, 000		.0645		Began to flake at joint of prisms *a* and *b*.
600, 000		.0688		
5, 000			.0232	
600, 000		.0702		
620, 000		.0735		
640, 000		.0765		
654, 800	4, 496	.0820		Ultimate strength.

Sudden failure under the maximum pressure. A continuous longitudinal seam opened along the three prisms, splitting off the corner of the pier. Other similar seams also opened.

The fragments of prism *a* assumed a pyramidal form with steep sides.

Prisms *b* and *c* were broken up by seams nearly parallel to the line of pressure.

4.—MORTAR AND CONCRETE CUBES MADE OF NORTON'S CEMENT.

The cubes were made in January, 1880, and were 46 months old when tested.

There were two compositions each of mortar and concrete, differing in the quantity of sand used.

All were prepared with plaster-of-paris bed faces, and were tested between steel cushions.

Compression measurements were taken with cubes 8″ to 16″ inclusive.

Pyramidal fractures were developed.

The average strengths of the cubes were as follows:

Mortar cubes.

	Pounds per square inch.
Composition A. M	1,545
Composition B. M	854

Concrete cubes.

Composition A	1,545
Composition B	1,021

Mortar A. M., containing 1½ parts sand has 80.9 per cent. higher strength than mortar B. M., containing 3 parts sand; and concrete A exceeded the strength of concrete B 51.3 per cent.

The addition of the broken stone to mortar A. M., thereby forming concrete A, did not result in any change of the average crushing resistance of the mixture; whereas with mortar B, the resulting concrete is 19.6 per cent. stronger than the mortar.

CRUSHING STRENGTH OF CUBES OF NORTON'S CEMENT MORTAR.

[COMPOSITION A. M.—1 part cement paste, 1½ parts sand.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.	Cushions.	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.
		Length.	Compressed surface.						Total.	Per square inch.	
		Inches.	*Inches.*	*Inches.*	*Sq. in.*		*Inch.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
116	4″ cube..	3.98	4.06	4.00	16.24	Steel..	.06	26,400	33,200	2,044	121.9
117	...do....	3.99	3.88	4.03	15.64	..do...	.08	32,100	32.100	2,052	122.1
118	6″ cube..	6.00	6.02	5.99	36.06	..do...	.12	49,700	49,700	1,378	117.8
119	.. do....	6.03	5.98	6.02	36.00	..do...	.17	46,900	46,900	1,303	117.8
120	8″ cube..	8.11	8.05	8.03	64.64	..do...	.03	106,000	106,000	1,640	122.0
121	...do....	7.99	8.05	8.05	64.80	..do...	.01	120,000	120,000	1,852	122.6
122	12″ cube.	12.03	12.03	12.07	145.20	..do...	.21	192,500	192,500	1,326	117.2
123	.. do....	12.07	12.02	12.02	144.48	..do...	.04	196,100	197,400	1,366	117.6
124	16″ cube.	16.05	16.00	16.01	256.16	..do...	.08	321,200	321,200	1,254	119.8
125	...do....	16.08	16.05	16.08	258.08	..do...	.09	320,000	320,000	1,240	118.5

CRUSHING STRENGTH OF CUBES, &C.—Continued.

[COMPOSITION A.—1 part cement paste, 1½ parts sand, 6 parts broken stone.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.	Cushions.	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.
		Length.	Compressed surface.						Total.	Per square inch.	
		Inches.	*Inches.*	*Inches.*	*Sq. in.*		*Inch.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
126	4″ cube..	4. 10	4. 00	4. 09	16. 36	Steel..	. 03	37, 950	37, 950	2, 320	137. 1
127	...do ...	4. 11	4. 05	4. 05	16. 40	..do ...	. 01	38, 100	38, 100	2, 323	141. 5
128	6″ cube..	6. 03	5. 97	6. 10	36. 42	..do ...	. 01	33, 000	33, 100	909	136. 0
129	...do	6. 03	6. 03	6. 07	36. 60	..do ...	. 02	35, 200	37, 200	1, 016	137. 1
130	8″ cube..	8. 06	8. 03	8. 07	64. 80	..do ...	. 10	87, 600	87, 600	1, 352	143. 6
131	...do	8. 04	8. 05	8. 04	64. 72	..do ...	. 03	97, 900	97, 900	1, 513	142. 6
132	12″ cube.	12. 02	12. 09	12. 00	145. 08	..do ...	. 10	184, 000	218, 100	1, 503	146. 7
133	...do	12. 05	12. 00	12. 00	144. 00	..do ...	. 10	200, 000	232, 900	1, 617	147. 9
134	16″ cube	16. 05	16. 10	16. 07	258. 73	..do ...	. 15	315, 000	379, 20[illegible]	1, 46[illegible]	146. 9
135	...do ...	16. 05	16. 04	16. 05	257. 44	..do ...	. 17	360, 000	368, 000	1, 429	146. 9

CRUSHING STRENGTH OF CUBES OF NORTON'S CEMENT CONCRETE.

[COMPOSITION B. M.—1 part cement paste, 3 parts sand.]

136	4″ cube..	3. 90	3. 98	3. 94	15. 68	Steel.	. 02	23, 250	23, 250	1, 483	120. 1
137*	...do	4. 00	3. 98	4. 00	15. 92	..do ...	. 06	18, 560	18. 560	1, 166	120. 9
138	6″ cube..	5. 98	6. 02	6. 03	36. 30	..do ...	. 03	28, 300	28, 300	780	116. 6
139	...do ...	5. 94	6. 02	6. 01	36. 18	..do ...	. 16	26, 050	26, 050	720	117. 3
140	8″ cube..	8. 05	7. 96	8. 04	64. 00	..do ...	. 13	54, 280	54, 280	848	117. 4
141	...do ...	8. 00	8. 05	8. 02	64. 56	..do ...	. 10	47, 250	47, 250	732	117. 2
142	12″ cube.	12. 00	12. 02	12. 06	144. 96	..do ...	. 08	98, 500	98, 500	680	115. 2
143	...do	12. 11	12. 11	12. 07	146. 17	..do ...	. 03	101, 600	101, 600	695	113. 8
144	16″ cube.	16. 10	16. 10	16. 11	259. 87	..do ...	. 14	194, 200	194, 200	749	114. 9
145	...do	16. 09	16. 07	16. 00	257. 12	..do ...	. 16	176, 750	176, 750	687	115. 9

*One compressed surface ″.00½ ± convex.

[COMPOSITION B.—1 part cement paste; 3 parts sand; 6 parts broken stone.]

146	4″ cube..	4. 07	3. 98	4. 00	15. 92	Steel.	. 04	23, 150	24, 700	1, 552	139. 9
147	...do	4. 02	3. 98	4. 00	15. 92	..do ...	. 21	27, 350	27, 350	1, 718	128. 2
148	6″ cube..	5. 90	6. 02	6. 00	36. 12	..do ...	. 17	36, 450	36, 450	1, 009	139. 9
149	...do ...	6. 00	5. 95	6. 00	35. 70	..do ...	. 07	35, 100	35, 380	991	139. 8
*150	8″ cube..	8. 02	8. 02	8. 00	64. 16	..do ...	. 14	56, 000	56, 400	879	140. 4
151	...do	8. 05	8. 00	8. 15	65. 20	..do ...	. 19	55, 000	55, 000	844	139. 9
152	12″ cube	12. 03	12. 01	12. 11	145. 44	..do ...	. 14	112, 650	112, 650	775	138. 3
153	...do	12. 05	12. 06	12. 05	145. 32	..do ...	. 09	109, 900	109, 900	757	138. 1
154	16″ cube.	16. 18	16. 14	16. 03	258. 72	..do ...	. 03	222, 100	222, 100	858	139. 9
155	.. do	16. 14	16. 12	16. 10	259. 53	..do ...	. 10	210, 000	215, 000	828	140. 0

*One compressed face convex ″.01 ±.

CUBES OF NORTON'S CEMENT MORTAR—COMPOSITION A. M.

No. 120.

Length, 8″.11.
Compressed surface, 8″.05 × 8″.03 = 64.64 square inches.
Weight, 37 pounds.
Total thickness of plaster, ″.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0015	....	
10,000	....	.0020	....	
15,000	....	.0030	....	
20,000	....	.0038	....	
25,000	....	.0042	....	
1,000	....	....	.0010	
25,000	....	.0042	....	
30,000	....	.0050	....	
35,000	....	.0060	....	
40,000	....	.0070	....	
45,000	....	.0075	....	
50,000	....	.0082	....	
1,000	....	....	.0022	
50,000	....	.0088	....	
55,000	....	.0095	....	
60,000	....	.0105	....	
65,000	....	.0115	....	
70,000	....	.0122	....	
75,000	....	.0138	....	
1,000	....	....	.0045	
75,000	....	.0142	....	
80,000	....	.0152	....	
85,000	....	.0165	....	
90,000	....	.0180	....	
95,000	....	.0200	....	
100,000	....	.0222	....	
105,000	....	.0252	....	
106,000	1,640	.0290	....	Ultimate strength.

Cracks appeared at time of reaching the maximum load.
Pyramidal fragments.

No. 121.

Length, 7″ 99.
Compressed surface, 8″.05 × 8″.05 = 64.80 square inches.
Weight, 36¾ pounds.
Total thickness of plaster, ″.01.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000		0.		
5,000		.0020		
10,000		.0030		
15,000		.0042		
20,000		.0050		
25,000		.0062		
1,000			.0010	
25,000		.0062		
30,000		.0070		
35,000		.0076		
40,000		.0085		
45,000		.0095		
50,000		.0102		
1,000			.0035	
50,000		.0105		
55,000		.0110		
60,000		.0120		
65,000		.0130		
70,000		.0140		
75,000		.0150		
1,000			.0052	
75,000		.0152		
80,000		.0160		
85,000		.0172		
95,000		.0200		
100,000		.0210		
105,000		.0230		
110,000		.0252		
115,000		.0280		
120,000	1,852	.0355		Ultimate strength.
118,000				Cracks appeared when pressure fell to this load.

Pyramidal fragments.

No. 122.

Length, 12″.03.
Compressed surface, 12″.03×12″.07=145.20 square inches.
Weight, 118½ pounds.
Total thickness of plaster, ″.21.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0045	....	
30,000	....	.0222	....	
40,000	....	.0420	....	
50,000	....	.0555	....	
5,000	....	....	.0520	
50,000	....	.0556	....	
60,000	....	.0630	....	
70,000	....	.0700	....	
80,000	....	.0755	....	
90,000	....	.0800	....	
100,000	....	.0845	....	
5,000	....	....	.0760	
100,000	....	.0870	....	
110,000	....	.0890	....	
120,000	....	.0920	....	
130,000	....	.0960	....	
140,000	....	.0990	....	
150,000	....	.1032	....	
160,000	....	.1075	....	
170,000	....	.1125	....	
180,000	....	.1185	....	
190,000	....	.1260	....	
192,500	1,326	.1330	....	Ultimate strength.

Surface cracks appeared soon after passing the maximum load.

A part of the unusual yielding of the cube was attributed to the plaster-of-paris, which was found soft and yielding after the test.

No. 123.

Length, 12''.07.
Compressed surface, 12''.02 × 12''.02 = 144.48 square inches.
Weight, 118¾ pounds.
Total thickness of plaster, ''.04.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0012	....	
20, 000	....	.0030	....	
30, 000	....	.0042	....	
40, 000	....	.0052	....	
50, 000	....	.0062	....	
5, 000	....	....	.0030	
50, 000	....	.0065	....	
60, 000	....	.0075	....	
70, 000	....	.0088	....	
80, 000	....	.0100	....	
90, 000	....	.0112	....	
100, 000	....	.0130	....	
5, 000	....	....	.0060	
100, 000	....	.0135	....	
110, 000	....	.0150	....	
120, 000	....	.0170	....	
130, 000	....	.0192	....	
140, 000	....	.0220	....	
150, 000	....	.0250	....	
5, 000	....	....	.0125	
150, 000	....	.0260	....	
160, 000	....	.0295	....	
170, 600	....	.0330	....	
180, 000	....	.0390	....	
190, 000	....	.0480	....	
196, 100	....	....	....	Cracks in sight.
197, 400	1, 366	.0650	....	Ultimate strength.

No. 124.

Length, 16''.05.
Compressed surface, 16''.00 × 16''.01 = 256.16 square inches.
Weight, 284 pounds.
Total thickness of plaster, ''.08.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0022	....	
30,000	....	.0038	....	
40,000	....	.0048	....	
50,000	....	.0058	....	
60,000	....	.0068	....	
70,000	....	.0075	....	
80,000	....	.0080	....	
90,000	....	.0090	....	
100,000	....	.0098	....	
5,000	....	....	.0030	
100,000	....	.0100	....	
120,000	....	.0110	....	
140,000	....	.0128	....	
160,000	....	.0145	....	
180,000	....	.0160	....	
200,000	....	.0185	....	
5,000	....	....	.0060	
200,000	....	.0192	....	
220,000	....	.0215	....	
230,000	....	.0225	....	
240,000	....	.0240	....	
250,000	....	.0258	....	
260,000	....	.0280	....	
270,000	....	.0292	....	
280,000	....	.0310	....	
290,000	....	.0340	....	
300,000	....	.0365	....	
310,000	....	.0392	....	
319,000	....	.0490	....	
320,000	....	.0555	....	
321,200	1,254	.0600	....	Ultimate strength.

No. 125.

Length, 16″.08.
Compressed surface, 16″.05 × 16″.08 = 258.08 square inches.
Weight, 284½ pounds.
Total thickness of plaster, ″.09.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0005		
20,000		.0015		
30,000		.0027		
40,000		.0040		
50,000		.0050		
60,000		.0060		
70,000		.0070		
80,000		.0075		
90,000		.0080		
100,000		.0090		
5,000			.0025	
100,000		.0090		
120,000		.0105		
140,000		.0120		
160,000		.0138		
180,000		.0155		
200,000		.0175		
5,000			.0052	
200,000		.0182		
220,000		.0200		
230,000		.0215		
240,000		.0230		
250,000		.0245		
260,000		.0262		
270,000		.0288		
280,000		.0310		
290,000		.0340		
300,000		.0390		
310,000		.0445		
320,000	1,240	.0520		Ultimate strength.

CUBES OF NORTON'S CEMENT MORTAR.—COMPOSITION B. M.

No. 140.

Length, 8″.05.
Compressed surface, 7″.96 × 8″.04 = 64.00 square inches.
Weight, 35 pounds.
Total thickness of plaster, ″.13.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0025	....	
10,000	....	.0042	....	
15,000	....	.0060	....	
20,000	....	.0075	....	
25,000	....	.0090	....	
1,000	....	....	.0030	
25,000	....	.0095	....	
30,000	....	.0110	....	
35,000	....	.0130	....	
40,000	....	.0150	....	
45,000	....	.0180	....	
50,000	....	.0230	....	
54,280	848	.0400	....	Ultimate strength.

No. 141.

Length, 8.00″.
Compressed surface, 8″.05 × 8″.02 = 64.56 square inches.
Weight, 35 pounds.
Total thickness of plaster, ″.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0030	....	
10,000	....	.0050	....	
15,000	....	.0060	....	
20,000	....	.0075	....	
25,000	....	.0090	....	
1,000	....	....	.0040	
25,000	....	.0095	....	
30,000	....	.0110	....	
35,000	....	.0130	....	
40,000	....	.0160	....	
45,000	....	.0230	....	
47,250	732	.0360	....	Ultimate strength.

No. 142.

Length, 12″.00.
Compressed surface, 12″.02 × 12″.06 = 144.96 square inches.
Weight, 116 pounds.
Total thickness of plaster, ″.08.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0012	....	
20,000	....	.0030	....	
30,000	....	.0040	....	
40,000	....	.0055	....	
50,000	....	.0069	....	
5,000	....	....	.0029	
50,000	....	.0072	....	
60,000	....	.0085	....	
70,000	....	.0108	....	
80,000	....	.0135	....	
90,000	....	.0180	....	
98,500	680	.0410	....	Ultimate strength.

No. 143.

Length, 12″.11.
Compressed surface, 12″.11 × 12″.07 = 146.17 square inches.
Weight, 116½ pounds.
Total thickness of plaster, ″.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0025	....	
30,000	....	.0040	....	
40,000	....	.0055	....	
50,000	....	.0070	....	
5,000	....	....	.0028	
50,000	....	.0075	....	
60,000	....	.0090	....	
70,000	....	.0120	....	
80,000	....	.0152	....	
90,000	....	.0210	....	
100,000	....	.0320	....	
101,600	695	.0410	....	Ultimate strength.

No. 144.

Length, 16″.10.
Compressed surface, 16″.10 × 16″.11 = 259.37 square inches.
Weight, 277½ pounds.
Total thickness of plaster, ″.14.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0010		
20, 000		.0025		
30, 000		.0035		
40, 000		.0042		
50, 000		.0052		
60, 000		.0065		
70, 000		.0075		
80, 000		.0082		
90, 000		.0095		
100, 000		.0110		
5, 000			.0042	
100, 000		.0112		
110, 000		.0125		
120, 000		.0140		
130, 000		.0160		
140, 000		.0180		
150, 000		.0205		
160, 000		.0235		
170, 000		.0272		
180, 000		.0320		
190, 000		.0420		
194, 200	749	.0560		Ultimate strength.

No. 145.

Length, 16″.09.
Compressed surface, 16″.07 × 16″.00 = 257.12 square inches.
Weight, 277½ pounds.
Total thickness of plaster, ″.16.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0020		
20, 000		.0038		
30, 000		.0050		
40, 000		.0062		
50, 000		.0072		
60, 000		.0082		
70, 000		.0098		
80, 000		.0110		
90, 000		.0122		
100, 000		.0140		
5, 000			.0055	
100, 000		.0145		
110, 000		.0160		
120, 000		.0172		
130, 000		.0192		
140, 000		.0225		
150, 000		.0258		
160, 000		.0302		
170, 000		.0380		
176, 750	687	.0540		Ultimate strength.

CUBES OF NORTON'S CEMENT CONCRETE—COMPOSITION A.

No. 130.

Length, 8".06.
Compressed surface, 8".03 × 8".07 = 64.80 square inches.
Weight, 43½ pounds.
Total thickness of plaster, ".10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0025	....	
10,000	....	.0030	....	
15,000	....	.0042	....	
20,000	....	.0050	....	
25,000	....	.0060	....	
1,000	....	....	.0030	
25,000	....	.0062	....	
30,000	....	.0070	....	
35,000	....	.0080	....	
40,000	....	.0090	....	
45,000	....	.0105	....	
50,000	....	.0122	....	
1,000	....	....	.0065	
50,000	....	.0130	....	
55,000	....	.0145	....	
60,000	....	.0175	....	
65,000	....	.0215	....	
70,000	....	.0260	....	
74,300	....	.0310	....	
75,000	....	.0325	....	
80,000	....	.0385	....	
85,000	....	.0485	....	
87,600	1,352	.0690	....	Ultimate strength.

No. 131.

Length, 8''.04.
Compressed surface, 8''.05 × 8''.04 = 64.72 square inches.
Weight, 43 pounds.
Total thickness of plaster, ''.03.
One compression face, ''.01 convex.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0040	....	
10,000	....	.0070	....	
15,000	....	.0085	....	
20,000	....	.0098	....	
25,000	....	.0110	....	
1,000	....	....	.0078	
25,000	....	.0115	....	
30,000	....	.0120	....	
35,000	....	.0140	....	
40,000	....	.0150	....	
45,000	....	.0170	....	
50,000	....	.0190	....	
1,000	....	....	.0130	
50,000	....	.0200	....	
55,000	....	.0220	....	
60,000	....	.0240	....	
65,000	....	.0275	....	
70,000	....	.0310	....	
75,000	....	.0350	....	
80,000	....	.0398	....	
85,000	....	.0450	....	
90,000	....	.0575	....	
95,000	....	.0710	....	
97,900	1,580	.1000	....	Ultimate strength.

No. 132.

Length, 12''.02.
Compressed surface, 12''.09 × 12''=145.08 square inches.
Weight, 148 pounds.
Total thickness of plaster, ''.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0010		
20, 000		.0020		
30, 000		.0030		
40, 000		.0040		
50, 000		.0050		
5, 000			.0022	
50, 000		.0050		
60, 000		.0060		
70, 000		.0070		
80, 000		.0080		
90, 000		.0095		
100, 000		.0110		
5, 000			.0052	
100, 000		.0120		
110, 000		.0130		
120, 000		.0150		
130, 000		.0170		
140, 000		.0198		
150, 000		.0230		
160, 000		.0265		
170, 000		.0310		
180, 000		.0362		
184, 000				Crack in sight.
190, 000		.0415		
200, 000		.0510		
210, 000		.0645		
215, 400		.0870		
218, 100	1, 508			Ultimate strength.

No. 133.

Length, 12″.05.
Compressed surface, 12″ × 12″=144 square inches.
Weight, 148½ pounds.
Total thickness of plaster, ″.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0015	....	
20, 000	....	.0042	....	
30, 000	....	.0058	....	
50, 000	....	.0085	....	
5, 000	....	....	.0050	
50, 000	....	.0087	....	
60, 000	....	.0100	....	
70, 000	....	.0115	....	
80, 000	....	.0130	....	
90, 000	....	.0148	....	
100, 000	....	.0160	....	
5, 000	....	....	.0098	
100, 000	....	.0170	....	
110, 000	....	.0185	....	
120, 000	....	.0200	....	
130, 000	....	.0220	....	
140, 000	....	.0245	....	
150, 000	....	.0280	....	
5, 000	....	....	.0172	
150, 000	....	.0292	....	
160, 000	....	.0320	....	
170, 000	....	.0340	....	
180, 000	....	.0380	....	
190, 000	....	.0430	....	
200, 000	....	.0500	....	Cracks in sight.
210, 000	....	.0590	....	
220, 000	....	.0720	....	
228, 800	....	.1100	....	
232, 900	1, 617	....	....	Ultimate strength.

No. 134.

Length, 16″.05.
Compressed surface, 16″.10 × 16″.07 = 258.73 square inches.
Weight, 353 pounds.
Total thickness of plaster, ″.15.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0008	....	
20,000	....	.0030	....	
30,000	....	.0042	....	
40,000	....	.0049	....	
50,000	....	.0054	....	
60,000	....	.0060	....	
70,000	....	.0065	....	
80,000	....	.0070	....	
90,000	....	.0075	....	
100,000	....	.0080	....	
5,000	....	....	.0044	
100,000	....	.0080	....	
120,000	....	.0090	....	
140,000	....	.0100	....	
160,000	....	.0115	....	
180,000	....	.0130	....	
200,000	....	.0150	....	
5,000	....	....	.0072	
200,000	....	.0160	....	
210,000	....	.0170	....	
220,000	....	.0182	....	
230,000	....	.0202	....	
240,000	....	.0222	....	
250,000	....	.0250	....	
260,000	....	.0278	....	
270,000	....	.0315	....	Snapping sound.
280,000	....	.0360	....	
290,000	....	.0400	....	
300,000	....	.0450	....	
310,000	....	.0500	....	
315,000	....	.0550	....	Cracks in sight.
320,000	....	.0600	....	
330,000	....	.0710	....	
340,000	....	.0805	....	
350,000	....	.0900	....	
360,000	....	.1090	....	
370,000	....	.1450	....	
379,200	1,466	.2030	....	Ultimate strength.

No. 135.

Length, 16''.10.
Compressed surface, 16''.04 × 16''.05 = 257.44 square inches.
Weight, 352½ pounds.
Total thickness of plaster, ''.17.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0008	....	
20,000	....	.0015	....	
30,000	....	.0025	....	
40,000	....	.0030	....	
50,000	....	.0038	....	
60,000	....	.0042	....	
70,000	....	.0050	....	
80,000	....	.0055	....	
90,000	....	.0060	....	
100,000	....	.0069	....	
5,000	....	....	.0030	
100,000	....	.0070	....	
120,000	....	.0080	....	
140,000	....	.0092	....	
160,000	....	.0110	....	
180,000	....	.0130	....	
200,000	....	.0150	....	
5,000	....	....	.0070	
200,000	....	.0160	....	
220,000	....	.0180	....	
230,000	....	.0192	....	
240,000	....	.0208	....	
250,000	....	.0235	....	
260,000	....	.0260	....	
270,000	....	.0290	....	
280,000	....	.0320	....	
290,000	....	.0360	....	
300,000	....	.0420	....	
310,000	....	.0500	....	
318,700	....	.0538	....	
320,000	....	.0580	....	
330,000	....	.0602	....	
340,000	....	.0650	....	
350,000	....	.0740	....	
360,000	....	.0875	....	Cracks in sight.
368,000	1,429	.1170	....	Ultimate strength.

CUBES OF NORTON'S CEMENT CONCRETE—COMPOSITION B.

No. 150.

Length, 8″.02.
Compressed surface, 8″.02×8″=64.16 square inches.
Weight, 42 pounds.
Total thickness of plaster, ″.14
One compressed face convex ″.01.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0	....	
5,000	....	.0062	....	
10,000	....	.0090	....	
15,000	....	.0110	....	
20,000	....	.0122	....	
25,000	....	.0142	....	
1,000	....	....	.0110	
25,000	....	.0150	....	
30,000	....	.0162	....	
35,000	....	.0185	....	
40,000	....	.0215	....	
45,000	....	.0258	....	
50,000	....	.0330	....	
54,300	....	.0480	....	
56,400	879	....	....	Ultimate strength.

No. 151.

Length, 8″.05.
Compressed surface, 8″×8″.15=65″.20 square inches.
Weight, 42½ pounds.
Total thickness of plaster, ″.19.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0	....	
5,000	....	.0022	....	
10,000	....	.0040	....	
15,000	....	.0055	....	
20,000	....	.0070	....	
25,000	....	.0085	....	
1,000	....	....	.0042	
25,000	....	.0090	....	
30,000	....	.0100	....	
35,000	....	.0120	....	
40,000	....	.0142	....	
45,000	....	.0172	....	
50,000	....	.0230	....	
55,000	844	.0450	....	Ultimate strength.

No. 152.

Length, 12″.03.
Compressed surface, 12″.01 x 12″.11 = 145.44 square inches.
Weight, 140 pounds.
Total thickness of plaster, ″.14.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0		
10,000		.0007		
20,000		.0022		
30,000		.0040		
40,000		.0050		
50,000		.0065		
5,000			.0030	
50,000		.0070		
60,000		.0080		
70,000		.0104		
80,000		.0125		
90,000		.0180		
100,000		.0290		
110,000		.0575		
112,650	775	.0760		Ultimate strength.

No. 153.

Length, 12″.05.
Compressed surface, 12″.06 x 12″.05 = 145.32 square inches.
Weight, 140 pounds.
Total thickness of plaster, ″.09.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0010		
20,000		.0025		
30,000		.0038		
40,000		.0049		
50,000		.0062		
5,000			.0025	
50,000		.0062		
60,000		.0075		
70,000		.0090		
80,000		.0112		
90,000		.0155		
100,000		.0240		
109,900	757	.0525		Ultimate strength.

No. 154.

Length, 16''.18.
Compressed surface, 16''.14×16''.03=258.72 square inches.
Weight, 339 pounds.
Total thickness of plaster, ''.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0008	....	
20,000	....	.0022	....	
30,000	....	.0040	....	
40,000	....	.0050	....	
50,000	....	.0062	....	
5,000	....	....	.0045	
50,000	....	.0065	....	
60,000	....	.0075	....	
70,000	....	.0084	....	
80,000	....	.0093	....	
90,000	....	.0105	....	
100,000	....	.0115	....	
5,000	....	....	.0072	
100,000	....	.0128	....	
110,000	....	.0130	....	
120,000	....	.0140	....	
130,000	....	.0150	....	
140,000	....	.0170	....	
150,000	....	.0180	....	
5,000	....	....	.0120	
150,000	....	.0190	....	
160,000	....	.0200	....	
170,000	....	.0215	....	
180,000	....	.0242	....	
190,000	....	.0272	....	
200,000	....	.0310	....	
210,000	....	.0360	....	
220,000	....	.0450	....	
222,100	858	.0500	....	Ultimate strength.
		.0660	....	After sustaining maximum load 5'.
		....	....	Cracks now appear.
		.0940	....	After sustaining maximum load 10'.
		.1450	....	After sustaining maximum load 12'.

Disintegration took place rapidly after the maximum load had been sustained twelve minutes.

No. 155.

Length, 16″.14.
Compressed surface, 16″.12×16″.10=259.53 square inches.
Weight, 339½ pounds.
Total thickness of plaster, ″.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0020	....	
30,000	....	.0030	....	
40,000	....	.0040	....	
50,000	....	.0045	....	
5,000	....	....	.0020	
50,000	....	.0047	....	
60,000	....	.0052	....	
70,000	....	.0060	....	
80,000	....	.0068	....	
90,000	....	.0075	....	
100,000	....	.0080	....	
5,000	....	....	.0035	
100,000	....	.0085	....	
110,000	....	.0092	....	
120,000	....	.0105	....	
130,000	....	.0120	....	
140,000	....	.0132	....	
150,000	....	.0150	....	
5,000	....	....	.0070	
150,000	....	.0162	....	
160,000	....	.0180	....	
170,000	....	.0210	....	
180,000	....	.0260	....	
190,000	....	.0320	....	
200,000	....	.0400	....	
210,000	....	.0540	....	Cracks in sight.
215,000	828	.0820	....	Ultimate strength.

MORTAR AND CONCRETE CUBES MADE OF NEWARK COMPANY'S ROSENDALE CEMENT.

The cubes were made in January, 1882, and were twenty-two months old when tested. All were prepared with plaster-of-paris bed faces.

The mortar cubes and one of each size of the concrete cubes, excepting the 4″, were tested between soft pine-wood cushions loaded perpendicularly to their grain. The pine cushions varied in thickness from ¼″ to 1″ with the different-sized cubes, and their cross-section dimensions were twice their own thickness plus the size of the cube with which used.

The duplicate concrete cubes were tested between steel cushions. Compression measurements of the latter cubes only were taken.

The manner of failures between pine cushions show clearly the want of uniformity in the composition of the mortar and concrete; also a decided loss in strength where so tested. The resistance of the pine cushions to crushing or indenting perpendicular to the grain was comparatively uniform, and when not indented uniformly it was occasioned principally by the inequality in strength of the mortar.

The difference in depth of the indentation of the cushions used with 8″ mortar cube, No. 90, was ″.17; with the concrete greater differences are found.

The grain of the cushions under opposite ends were at first placed in a parallel direction. It was observed that the compressed surfaces of the cubes cleaved in lines parallel to the grain of the cushions, the yielding of the wood influencing the manner of failure, and instead of pyramidal fragments found, as when tested between steel cushions, these cubes were broken into thin layers. When the grain of the cushions on opposite ends were at right angles, the lines of cleavage of the cubes were at right angles, following the grain of the wood.

Changing the direction of the grain of the cushions had no apparent effect on the strength of the cube. In passing, however, from wood to steel cushions there was a gain of 24.5 per cent. in the average resistance of the cubes.

Comparing the strength of the mortar cubes, 4″ to 16″, inclusive, tested between wooden cushions, with concrete tested between the same kind of cushions, the average resistance of the concrete is found 20.9 per cent. above the mortar.

CRUSHING STRENGTH OF CUBES OF NEWARK COMPANY'S ROSENDALE CEMENT MORTAR.

[Composition—one part cement, three parts sand.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.
		Length.	Compressed surface.		
		Inches.	*Inches.*	*Inches.*	*Sq. inches.*
84	2″ cube	2.07	2.00	2.02	4.04
85	......do	1.98	2.04	2.08	4.24
86	4″ cube	3.98	3.98	4.00	15.9
87	......do	4.05	3.96	3.96	15.7
88	6″ cube	5.95	5.93	6.00	35.6
89	......do	6.00	5.93	5.95	35.8
90	8″ cube	7.95	8.02	8.06	64.6
91	......do	8.12	8.10	8.10	65.7
92	10″ cube	10.00	10.00	10.10	101.0
93	......do	10.04	10.10	10.06	101.6
94	12″ cube	12.00	12.00	12.04	144.5
95	......do	11.90	12.00	12.05	144.6
96	14″ cube	13.90	14.00	13.98	195.7
97	......do	14.02	14.10	14.08	198.5
98	16″ cube	16.00	16.00	16.00	256.0
99	......do	16.04	16.04	16.02	257.0

No. of test.	Cushions.	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.
				Total.	Per square inch.	
		Inch.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
84	¼″ wood	.06	6,600	6,680	1,653	122.7
85	......do	.09	4,700	5,350	1,261	119.0
86	½″ wood	.14	11,600	11,960	753	118.0
87	......do	.09	11,350	12,100	771	115.2
88	......do	.13	28,050	29,100	817	114.3
89	......do	.13	27,300	27,600	782	114.8
90	¾″ wood	.06	45,100	45,300	701	115.9
91	......do	.13	44,300	46,800	712	112.6
92	......do	.15	81,600	83,600	828	117.1
93	......do	.11	71,700	108,000	1,063	118.1
94	1″ wood	.08	100,200	101,000	699	114.1
95	......do	.15	91,400	97,100	671	114.9
96	......do	.13	132,000	136,500	697	117.7
97	......do	.10	139,700	145,600	733	116.6
98	......do	.07	140,000	157,000	613	114.5
99	......do	.13	147,000	158,000	615	118.8

Table showing appearance of cushions, and remarks upon the fractures of the cubes in the foregoing tests of Newark Company's Rosendale cement mortar.

No. of test.	Size of cube.	Direction of grain of cushions.	Appearance of cushions after the test.			Remarks upon fractures of the cubes.
			Increase in width.		Remarks.	
	In.		*Inch.*			
84	2	Parallel. ..	.06	.06	Indented to a depth of ".04 to ".09.	Pyramidal fragments.
85	2	....do	.07	.05	Indented uniformly ".05	Do.
86	4	... do	.16	.08	Indented, maximum ".07, minimum ".02.	Cleaved in lines parallel to grain of cushions.
87	4	....do	.06	.15	Indented, maximum ".07, minimum ".01.	Do.
88	6	....do	0	.19	Indented, maximum ".04, minimum ".01.	
89	6	....do	0	0	Indented, maximum ".01, minimum ".00½.	Pyramidal fragments.
90	8	....do	.14	.27	Indented, maximum ".18, minimum ".01.	
91	8	....do	0	.02	Indented, maximum ".02, minimum ".01.	Do.
92	10	... do	.07	.05	Indented, maximum ".07, minimum ".07.	Pyramidal fragments; cleavage parallel to grain of cushions.
93	10	Crosswise ..	.32	.55	Indented, maximum ".22, minimum ".15.	Cleavage on each compressed face parallel to grain of cushions.
94	12	Parallel.....	.04	.04	Indented, maximum ".03, minimum ".02.	Pyramidal fragments.
95	12	Crosswise ..	.01	.01	Indented, maximum ".03, minimum ".01½.	Pyramidal fragments with cleavage parallel to grain of cushions.
96	14	Parallel....	.02	.03	Indented, maximum ".06, minimum ".02.	Sides split off leaving solid core.
97	14	Crosswise ..	.10	.60	Indented, maximum ".17, minimum ".04.	
98	16	Parallel.....	0	.04	Indented, maximum ".02, minimum ".00½.	Sides split off leaving solid core of softer material.
99	16	Crosswise ..	0	.03	Indented, maximum ".03, minimum ".01.	Do.

CRUSHING STRENGTH OF CUBES OF NEWARK COMPANY'S ROSENDALE CEMENT CONCRETE.

[Composition—1 part cement, 3 parts sand, 2 parts gravel, 4 parts broken stone.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.
		Length.	Compressed surface.		
		Inch.	*Inch.*	*Inch.*	
100	4-inch cube ...	4.07	4.08	4.05	16.52
101	... do	4.02	4.06	4.07	16.52
102	6-inch cube ...	6.02	5.95	6.08	36.18
103	....do	6.12	6.02	6.09	36.66
104	8-inch cube ...	8.00	8.07	8.09	65.28
105	....do	8.02	8.02	8.05	64.56
106	10-inch cube ..	10.13	10.11	10.11	102.21
107	... do	10.16	10.11	10.04	101.50
108	12-inch cube ..	12.05	12.04	12.13	146.04
109	.. do	12.00	12.06	12.04	145.20
110	14-inch cube ..	14.14	13.90	14.18	197.10
111	....do	14.04	14.09	14.05	197.96
112	16-inch cube ..	16.03	16.08	16.16	259.85
113	.. do	16.00	16.05	16.10	258.40
114	18-inch cube ..	18.00	17.95	18.02	323.46
115	....do	18.00	18.00	17.62	317.16

No. of test.	Cushions.	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.
				Total.	Per square inch.	
		Inch.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
100	½-inch wood..	.08	15,300	17,750	1,074	126.8
101	⅜-inch wood..	.10	14,900	16,380	991	126.8
102	½-inch wood..	.02	35,200	37,100	1,025	127.4
103	Steel.........	.07	41,500	45,100	1,230	127.1
104	¾-inch wood..	.14	43,600	55,200	846	134.5
105	Steel.........	.10	65,500	77,100	1,194	130.1
106	¾-inch wood..	.02	84,400	117,700	1,152	132.6
107	Steel.........	.06	120,000	120,000	1,182	130.7
108	1-inch wood..	.13	108,000	121,300	831	132.5
109	Steel.........	.02	150,000	161,600	1,113	134.9
110	1-inch wood..	.08	134,000	137,500	698	133.3
111	Steel.........	.09	147,000	148,000	748	131.2
112	1-inch wood..	.13	130,000	175,200	674	133.9
113	Steel.........	.07	250,000	268,400	1,039	136.1
114	1-inch wood..	.08	220,000	271,300	839	136.1
115	Steel.........	.19	331,000	331,000	1,044	137.1

Table showing appearance of cushions, and remarks upon the fractures of the cubes, in the foregoing tests of Newark Company's Rosendale cement concrete.

No. of test.	Size of cube.	Direction of grain of cushions.	Appearance of cushions after the test.		Remarks upon fractures of the cubes.
			Increase in width.	Remarks.	
	In.		*Inch.*		
100	4	Parallel...	.07 .03	Indented, maximum ".13, minimum ".01.	Failed in detail, crushing from one side, cleaving in lines parallel to grain of cushions.
101	4	...do	.18 .25	Indented, maximum ".15, minimum ".02.	Do.
102	6	..do	.14 .10	Indented, maximum ".06, minimum ".00½.	Pyramidal fragments. Compressed faces cleaving in lines parallel to grain of cushions.
103	6	....	....	Steel cushions	Pyramidal fragments.
104	8	Parallel...	.25 .08	Indented, maximum ".30, minimum ".05.	Cube crushed in detail.
105	8	....	....	Steel cushions	Pyramidal fragments.
106	10	Parallel...	.11 .12	Indented, maximum ".32, minimum ".28.	Do.
107	10	....	....	Steel cushions	Do.
108	12	Parallel...	.06 .08	Indented, maximum ".15, minimum ".05.	Pyramidal fragments. Compressed faces showed slight cleavage parallel to grain of cushions.
109	12	....	....	Steel cushions	Pyramidal fragments.
110	14	Parallel...	.08 .30	Indented, maximum ".15, minimum ".01.	Compressed faces showed slight cleavage parallel to grain of cushions.
111	14	....	....	Steel cushions	Pyramidal fragments.
112	16	Parallel ..	.42 .08	Indented, maximum ".12, minimum ".00½.	Pyramidal fragments. Compressed faces showed slight cleavage parallel to grain of cushions.
113	16	....	....	Steel cushions	Pyramidal fragments.
114	18	Parallel...	.50 .60	Indented, maximum ".25, minimum ".02.	Pyramidal fragments. Compressed faces showed slight cleavage parallel to grain of cushions.
115	18	....	....	Steel cushions	Pyramidal fragments.

CONCRETE CUBES OF NEWARK COMPANY'S ROSENDALE CEMENT.

No. 107.

Length, 10''.16.
Compressed surface, 10''.11 × 10''.04=101.50 square inches.
Weight, 78 pounds.
Total thickness of plaster, ''.06.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
15,000	....	.0020	....	
20,000	....	.0030	....	
25,000	....	.0040	....	
30,000	....	.0048	....	
35,000	....	.0058	....	
40,000	....	.0065	....	
45,000	....	.0075	....	
50,000	....	.0082	....	
5,000	....	....	.0051	
50,000	....	.0088	....	
55,000	....	.0097	....	
60,000	....	.0110	....	
65,000	....	.0120	....	
70,000	....	.0140	....	
75,000	....	.0155	....	
80,000	....	.0180	....	
85,000	....	.0200	....	
90,000	....	.0230	....	
95,000	....	.0270	....	
100,000	....	.0320	....	
105,000	....	.0385	....	
110,000	....	.0500	....	
115,000	....	.0670	....	
120,000	1,182	.1000	....	Ultimate strength.

Surface cracks appeared immediately before the maximum load was reached.

The cube crushed into pyramidal shape.

No. 109.

Length, 12''.00.
Compressed surface, 12''.06 × 12''.04 = 145.20 square inches.
Weight, 136 pounds.
Total thickness of plaster, ''.02.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
15,000	....	.0025	....	
20,000	....	.0035	....	
25,000	....	.0042	....	
30,000	....	.0052	....	
35,000	....	.0060	....	
40,000	....	.0070	....	
45,000	....	.0075	....	
50,000	....	.0080	....	
5,000	....	....	.0048	
50,000	....	.0082	....	
55,000	....	.0092	....	
60,000	....	.0100	....	
65,000	....	.0110	....	
70,000	....	.0120	....	
75,000	....	.0130	....	
80,000	....	.0140	....	
85,000	....	.0150	....	
90,000	....	.0160	....	
95,000	....	.0175	....	
100,000	....	.0190	....	
5,000	....	....	.0125	
100,000	....	.0210	....	
105,000	....	.0225	....	
110,000	....	.0240	....	
115,000	....	.0250	....	
120,000	....	.0270	....	
125,000	....	.0294	....	
130,000	....	.0335	....	
135,000	....	.0368	....	
140,000	....	.0420	....	
145,000	....	.0480	....	
150,000	....	.0560	....	Cracks developed
155,000	....	.0680	....	
160,000	....	.0950	....	
161,600	1,113	....	....	Ultimate strength.

Pyramidal fragments.

No. 111.

Length, 14''.04.
Compressed surface, 14''.09 × 14''.05 = 197.96 square inches.
Weight, 211 pounds.
Total thickness of plaster, ''.09.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0015	....	
20,000	....	.0030	....	
30,000	....	.0042	....	
40,000	....	.0060	....	
50,000	....	.0070	....	
5,000	....	....	.0045	
50,000	....	.0080	....	
60,000	....	.0092	....	
70,000	....	.0110	....	
80,000	....	.0125	....	
90,000	....	.0160	....	
100,000	....	.0200	....	
5,000	....	....	.0130	
100,000	....	.0220	....	
110,000	....	.0275	....	
120,000	....	.0350	....	
130,000	....	.0490	....	
140,000	....	.0720	....	
147,000	....	....	....	Cracks in sight.
148,000	748	.1870	....	Ultimate strength.

No. 113.

Length, 16″.00.
Compressed surface, 16″.05 × 16″.10=258.40 square inches.
Weight, 325½ pounds.
Total thickness of plaster, ″.07.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0012		
20,000		.0028		
30,000		.0036		
40,000		.0040		
50,000		.0048		
5,000			.0028	
50,000		.0049		
60,000		.0052		
70,000		.0062		
80,000		.0069		
90,000		.0075		
100,000		.0083		
5,000			.0042	
100,000		.0090		
110,000		.0100		
120,000		.0110		
130,000		0120		
140,000		.0135		
150,000		.0150		
5,000			.0080	
150,000		.0162		
160,000		.0175		
170,000		.0210		
180,000		.0235		
190,000		.0275		
200,000		.0325		
210,000		.0385		
220,000		.0440		
230,000		.0500		
240,000		.0605		
250,000		.0720		Cracks in sight.
260,000		.0922		
268,400	1,039			Ultimate strength.

No. 115.

Length, 18″.
Compressed surface, 18″×17″.62=317.16 square inches.
Weight, 455 pounds.
Total thickness of plaster, ″.19.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0004		
20,000		.0015		
40,000		.0040		
60,000		.0060		
80,000		.0072		
100,000		.0090		
5,000			.0045	
100,000		.0092		
120,000		.0105		
140,000		.0120		
160,000		.0140		
180,000		.0162		
200,000		.0190		
5,000			.0100	
200,000		.0212		
210,000		.0220		
220,000		.0230		
230,000		.0240		
240,000		.0260		
250,000		.0290		
260,000		.0320		
270,000		.0360		
280,000		.0410		
290,000		.0455		
300,000		.0520		
310,000		.0615		
320,000		.0695		
330,000		.0808		
331,100	1,044	.0930		Ultimate strength.

MORTAR AND CONCRETE CUBES MADE OF NATIONAL PORTLAND CEMENT.

The cubes were made in January, 1880, and were forty-six months old when tested.

The bed surfaces were faced with plaster-of-paris, and they were tested between steel cushions.

Compression measurements were taken of cubes from 8″ to 16″, and recorded in the details of the tests.

The average crushing resistance of the cubes was as follows: For the mortar, 2,707 pounds per square inch; for the concrete, 3,067 pounds per square inch; the strength of the concrete exceeding that of the mortar 13.3 per cent.

Concrete cube No. 175 was crushed by repeated loading. It sustained 800,000 pounds (maximum load of the testing-machine) when first applied with but slight injury, a few cracks being opened.

The second application of 800,000 pounds increased the compression of the cube from ″.0600 to ″.0665. This load was now allowed to act ten minutes, which further increased the compression ″.0087, or to ″.0752 total amount.

Under the third application of load the cube was compressed ″.0810, which now was increased to ″.0120 while the load was acting ten minutes, the total compression amounting to ″.0930.

Returning to the initial load, 5,000 pounds, the temporary set was found ″.0550, which in two minutes was reduced to ″.0535, in four minutes to ″.0532. No further change took place after six minutes' rest.

The load was again increased the fourth and final time to 800,000 pounds. The total compression was at first ″.1020, which increased to ″.1210 in two minutes' time, when the cube rapidly failed.

CRUSHING STRENGTH OF CUBES OF NATIONAL PORTLAND CEMENT MORTAR.

[Composition—1 part cement paste, 3 parts sand.]

No. of test.	Nominal dimensions.	Actual dimensions.			Sectional area.
		Length.	Compressed surface.		
		Inches.	*Inches.*	*Inches.*	*Sq. inches.*
156	4″ cube	4.00	4.03	4.04	16.28
157	....do	4.05	4.02	3.98	16.00
158	6″ cube	5.97	6.02	5.99	36.06
159	....do	5.93	6.00	5.98	35.88
160	8″ cube	8.01	8.08	8.04	64.96
161	....do	8.13	8.01	7.90	63.28
162	12″ cube	12.07	12.00	12.05	144.60
163	....do	12.10	12.02	12.00	144.24
164	16″ cube	16.22	16.12	16.12	259.85
165	....do	16.12	16.04	16.08	257.92

No. of test.	Cushions	Thickness of plaster.	Cracks in sight.	Ultimate strength.		Weight per cubic foot.
				Total.	Per square inch.	
		Inch.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
156	Steel	.11	58,800	58,800	3,612	120.9
157	....do	.05	52,600	52,600	3,287	119.9
158	....do	.12	99,800	99,800	2,767	118.1
159	....do	.06	91,200	91,200	2,542	118.5
160	... do	.12	168,000	168,000	2,586	117.9
161	....do	.12	150,000	150,000	2,370	117.8
162	....do	.08	357,400	357,400	2,472	123.8
163	... do	.05	345,600	345,600	2,396	124.2
164	....do	.02	650,000	650,000	2,501	116.0
165	....do	.08	654,500	654,500	2,538	117.6

No. 161.

Length, 8″.13.
Compressed surface, 8″.01 × 7″.90=63.28 square inches.
Weight, 35 pounds.
Total thickness of plaster, ″.12.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0030	....	
10,000	....	.0045	....	
20,000	....	.0065	....	
30,000	....	.0075	....	
40,000	....	.0088	....	
50,000	....	.0100	....	
1,000	....	....	.0032	
50,000	....	.0100	....	
60,000	....	.0110	....	
70,000	....	.0120	....	
80,000	....	.0130	....	
90,000	....	.0140	....	
100,000	....	.0152	....	
1,000	....	....	.0045	
100,000	....	.0158	....	
110,000	....	.0165	....	
120,000	....	.0180	....	
130,000	....	.0198	....	
140,000	....	.0220	....	
150,000	....	.0250	....	
1,000	....	....	.0090	
150,000	2,370	.0310	....	Ultimate strength.

No. 162.

Length, 12″.07.
Compressed surface, 12″×12″.05=144.60 square inches.
Weight, 125 pounds.
Total thickness of plaster, ″.08.

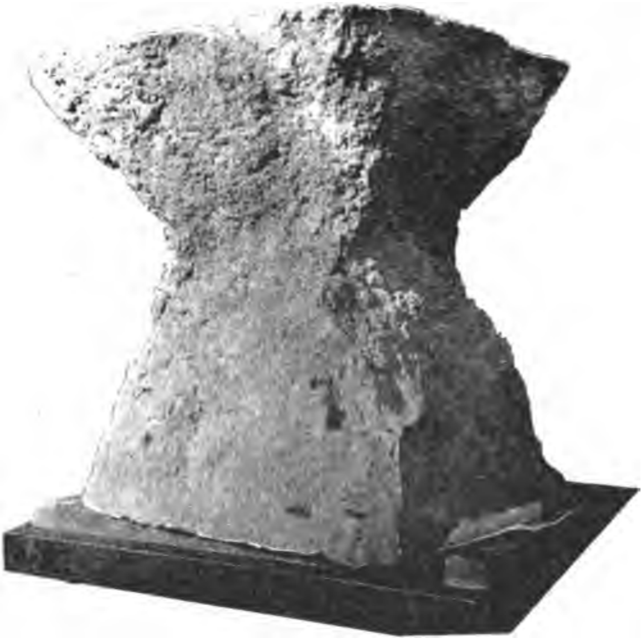
Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0010	....	
20,000	....	.0015	....	
40,000	....	.0023	....	
60,000	....	.0040	....	
80,000	....	.0048	....	
100,000	....	.0058	....	
5,000	....	....	.0029	
100,000	....	.0062	....	
120,000	....	.0070	....	
140,000	....	.0075	....	
160,000	....	.0082	....	
180,000	....	.0090	....	
200,000	....	.0102	....	
5,000	....	....	.0031	
200,000	....	.0102	....	
220,000	....	.0115	....	
240,000	....	.0125	....	
260,000	....	.0140	....	
280,000	....	.0156	....	
290,000	....	.0168	....	
300,000	....	.0178	....	
5,000	....	....	.0048	
300,000	....	.0180	....	
310,000	....	.0190	....	
320,000	....	.0200	....	
330,000	....	.0210	....	
340,000	....	.0222	....	
350,000	....	.0242	....	
357,400	2,472	.0272	....	Ultimate strength.

No. 163.

Length, 12″.10.
Compressed surface, 12″.02 × 12″ = 144.24 square inches.
Weight, 125½ pounds.
Total thickness of plaster, .05″.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0002	....	
20,000	....	.0009	....	
40,000	....	.0020	....	
60,000	....	.0029	....	
80,000	....	.0038	....	
100,000	....	.0045	....	
5,000	....	....	.0010	
100,000	....	.0045	....	
120,000	....	.0057	....	
140,000	....	.0068	....	
160,000	....	.0078	....	
180,000	....	.0090	....	
200,000	....	.0102	....	
5,000	....	....	.0022	
200,000	....	.0107	....	
220,000	....	.0120	....	
240,000	....	.0132	....	
260,000	....	.0150	....	
270,000	....	.0159	....	
280,000	....	.0168	....	
290,000	....	.0180	....	
300,000	....	.0190	....	
5,000	....	....	.0050	
300,000	....	.0195	....	
310,000	....	.0210	....	
320,000	....	.0220	....	
330,000	....	.0235	....	
340,000	....	.0260	....	
345,600	2,396	.0290	....	Ultimate strength.

PHOTOGRAPH OF FRACTURED CUBE OF NATIONAL PORTLAND CEMENT MORTAR (No. 163).



No. 164.

Length, 16″.22.
Compressed surface, 16″.12 × 16″.12 = 259.85 square inches.
Weight, 283 pounds.
Total thickness of plaster, ″.02.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0002		
20,000		.0002		
40,000		.0008		
60,000		.0012		
80,000		.0020		
100,000		.0026		
5,000			.0015	
100,000		.0028		
120,000		.0031		
140,000		.0037		
160,000		.0042		
180,000		.0048		
200,000		.0050		
5,000			.0025	
200,000		.0055		
220,000		.0060		
240,000		.0064		
260,000		.0070		
280.000		.0075		
300,000		.0080		
5,000			.0038	
300,000		.0085		
320,000		.0090		
340,000		.0096		
360,000		.0102		
380,000		.0110		
400,000		.0118		
5,000			.0052	
400,000		.0120		
420,000		.0125		
440,000		.0132		
460,000		.0140		
480,000		.0150		
500,000		.0160		
5,000			.0070	
500,000		.0165		
520,000		.0172		
540,000		.0181		
560,000		.0188		
580,000		.0202		
600,000		.0215		
5,000			.0095	
600,000		.0230		
610,000		.0235		
620,000		.0242		
630,000		.0250		
640,000		.0260		
650,000	2,501	.0272		Ultimate strength.

No. 165.

Length, 16″.12.
Compressed surface, 16″.04 × 16″.08 = 257.92 square inches.
Weight, 283 pounds.
Total thickness of plaster, ″.08.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000		0.		
10, 000		.0002		
20, 000		.0005		
40, 000		.0013		
80, 000		.0030		
100, 000		.0035		
5, 000			.0015	
100, 000		.0035		
140, 000		.0050		
180, 000		.0062		
200, 000		.0070		
5, 000			.0022	
200, 000		.0070		
240, 000		.0080		
280, 000		.0094		
300, 000		.0102		
5, 000			.0032	
300, 000		.0102		
340, 000		.0118		
380, 000		.0132		
400, 000		.0142		
5, 000			.0042	
400, 000		.0148		
420, 000		.0152		
440, 000		.0162		
460, 000		.0171		
480, 000		.0180		
500, 000		.0190		
5, 000			.0060	
500, 000		.0198		
520, 000		.0208		
540, 000		.0220		
560, 000		.0230		
580, 000		.0242		
600, 000		.0255		
5, 000			.0080	
600, 000		.0265		
610, 000		.0275		
620, 000		.0284		
630, 000		.0292		
640, 000		.0304		
650, 000		.0330		
654, 500	2, 538			Ultimate strength.

CONCRETE CUBES MADE OF NATIONAL PORTLAND CEMENT.

No. 170.

Length, 8''.11.
Compressed surface, 8''.4 × 7''.99 = 64.24 square inches.
Weight, 43 pounds.
Total thickness of plaster, ''.13.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000		0.		
5,000		.0040		
10,000		.0045		
15,000				
20,000		.0057		
25,000				
1,000				
25,000				
30,000		.0065		
40,000		.0070		
50,000		.0080		
1,000			.0042	
50,000		.0080		
60,000		.0085		
70,000		.0095		
80,000		.0102		
90,000		.0112		
100,000		.0120		
1,000			.0055	
100,000		.0125		
110,000		.0132		
120,000		.0145		
130,000		.0160		
140,000		.0175		
150,000		.0195		
160,000		.0220		
170,000		.0255		
180,000		.0300		
190,000		.0365		
196,500	3,059	.0480		Ultimate strength.

No. 171.

Length, 8''.18.
Compressed surface, 8''.05 × 8''.03 = 64.64 square inches.
Weight, 43 pounds.
Total thickness of plaster, ''.03.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
1,000	....	0.	....	
5,000	....	.0010	....	
10,000	....	.0020	....	
20,000	....	.0032	....	
30,000	....	.0042	....	
40,000	....	.0052	....	
50,000	....	.0062	....	
1,000	....	....	.0020	
50,000	....	.0065	....	
60,000	....	.0072	....	
70,000	....	.0082	....	
80,000	....	.0095	....	
90,000	....	.0110	....	
100,000	....	.0125	....	
1,000	....	....	.0048	
100,000	....	.0132	....	
110,000	....	.0150	....	
120,000	....	.0170	....	
130,000	....	.0200	....	
140,000	....	.0225	....	
150,000	....	.0250	....	
160,000	....	.0275	....	
170,000	....	.0310	....	
180,000	....	.0350	....	
190,000	....	.0415	....	
193,500	2,994	.0480	....	Ultimate strength.

No. 172.

Length, 12″.09.
Compressed surface, 12″ × 12″.04=144.48 square inches.
Weight, 143 pounds.
Total thickness of plaster, ″.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5, 000	....	0.	....	
10, 000	....	.0010	....	
20, 000	....	.0020	....	
40, 000	....	.0032	....	
60, 000	....	.0042	....	
80, 000	....	.0052	....	
100, 000	....	.0065	....	
5, 000	....	....	.0030	
100, 000	....	.0065	....	
120, 000	....	.0075	....	
140, 000	....	.0085	....	
160, 000	....	.0100	....	
180, 000	....	.0125	....	
190, 000	....	.0140	....	
200, 000	....	.0155	....	
5, 000	....	....	.0090	
200, 000	....	.0162	....	
210, 000	....	.0180	....	
220, 000	....	.0195	....	
230, 000	....	.0220	....	
240, 000	....	.0240	....	
250, 000	....	.0260	....	
260, 000	....	.0280	....	
270, 000	....	.0300	....	
280, 000	....	.0325	....	
290, 000	....	.0345	....	
300 000	....	.0372	....	
5, 000	....	....	.0248	
300, 000	....	.0400	....	
310, 000	....	.0420	....	
320, 000	....	.0440	....	
330, 000	....	.0472	....	
340, 000	....	.0505	....	
350, 000	....	.0540	....	
360, 000	....	.0615	....	
365, 500	....	.0670	....	Cracks in sight.
367, 000	2, 540	.0720	....	Ultimate strength.

No. 173.

Length, 12″.10.
Compressed surface, 12″×12″.03=144.36 square inches.
Weight, 143½ pounds.
Total thickness of plaster, ″.08.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0010		
20,000		.0023		
40,000		.0045		
60,000		.0058		
80,000		.0068		
100,000		.0078		
5,000			.0040	
100,000		.0080		
120,000		.0087		
140,000		.0098		
160,000		.0108		
180,000		.0118		
200,000		.0130		
5,000			.0060	
200,000		.0130		
220,000		.0140		
240,000		.0150		
260,000		.0170		
280,000		.0180		
300,000		.0200		
5,000			.0100	
300,000		.0212		
310,000		.0222		
320,000		.0230		
330,000		.0242		
340,000		.0260		
350,000		.0275		
360,000		.0292		
370,000		.0312		
380,000		.0345		
390,000		.0380		
400,000		.0400		
410,000	2,840	.0500		Ultimate strength.

No. 174.

Length, 16″.11.
Compressed surface, 16″.06×16″.15=259.37 square inches.
Weight, 345 pounds.
Total thickness of plaster, ″.08.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0002		
20,000		.0009		
40,000		.0018		
80,000		.0030		
100,000		.0035		
5,000			.0020	
100,000		.0037		
140,000		.0050		
180,000		.0062		
200,000		.0069		
5,000			.0030	
200,000		.0070		
240,000		.0080		
280,000		.0095		
300,000		.0102		
5,000			.0042	
300,000		.0105		
340,000		.0120		
380,000		.0136		
400,000		.0148		
5,000			.0060	
400,000		.0152		
420,000		.0162		
440,000		.0170		
460,000		.0182		
480,000		.0198		
500,000		.0210		
5,000			.0085	
500,000		.0220		
520,000		.0231		
540,000		.0245		
560,000		.0260		
580,000		.0278		
600,000		.0300		
5,000			.0182	
600,000		.0322		
610,000		.0340		
620,000		.0350		
640,000		.0365		
650,000		.0375		
660,000		.0390		
670,000		.0410		
680,000		.0436		
690,000		.0465		
700,000		.0502		
710,000		.0535		Cracks in sight.
720,000		.0560		
730,000		.0610		
738,000		.0710		
740,000		.0770		
747,000	2,880	.0820		Ultimate strength.

No. 175.

Length, 16″.16.
Compressed surface, 16″.17 × 16″.08=260.01 square inches.
Weight, 352 pounds.
Total thickness of plaster, ″.08.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
10,000		.0005		
20,000		.0012		
40,000		.0020		
80,000		.0030		
100,000		.0039		
5,000			.0020	
100,000		.0040		
140,000		.0050		
180,000		.0060		
200,000		.0065		
5,000			.0030	
200,000		.0067		
240,000		.0075		
280,000		.0088		
300,000		.0092		
5,000			.0039	
300,000		.0096		
340,000		.0110		
380,000		.0120		
400,000		.0130		
5,000			.0050	
400,000		.0135		
440,000		.0150		
480,000		.0162		
500,000		.0175		
5,000			.0068	
500,000		.0182		
540,000		.0202		
580,000		.0222		
600,000		.0240		
5,000			.0095	
600,000		.0258		
610,000		.0268		
620,000		.0272		
630,000		.0280		
650,000		.0290		
660,000		.0300		
670,000		.0305		
680,000		.0315		
690,000		.0330		
700,000		.0348		
710,000		.0358		
720,000		.0365		
730,000		.0375		
740,000		.0390		
750,000		.0405		
760,000		.0430		
770,000		.0448		
780,000		.0465		
790,000		.0490		
795,000		.0510		
800,000		.0580		
5,000			.0270	
100,000		.0335		
200,000		.0380		
300,000		.0420		
400,000		.0450		
500,000		.0480		
600,000		.0510		
700,000		.0540		Cracks in sight.
800,000		.0600		Do.
5,000			.0320	
400,000		.0520		
600,000		.0570		
700,000		.0610		

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
800,000		.0665		
		.0692		After sustaining load 2 minutes.
		.0720		After sustaining load 4 minutes.
		.0730		After sustaining load 6 minutes.
		.0740		After sustaining load 8 minutes.
		.0752		After sustaining load 10 minutes.
5,000			.0415	
			.0410	After 2 minutes' rest.
			.0405	After 4 minutes' rest.
			.0405	After 6 minutes' rest.
100,000		.0500		
200,000		.0570		
300,000		.0610		
400,000		.0650		
500,000		.0680		
600,000		.0710		
700,000		.0740		
800,000		.0810		
		.0850		After sustaining load 2 minutes.
		.0880		After sustaining load 4 minutes.
		.0890		After sustaining load 6 minutes.
		.0910		After sustaining load 8 minutes.
		.0930		After sustaining load 10 minutes.
5,000			.0550	
			.0535	After 2 minutes rest.
			.0532	After 4 minutes rest.
			.0532	After 6 minutes rest.
100,000		.0660		
200,000		.0720		
300,000		.0770		
400,000		.0812		
500,000		.0850		
600,000		.0885		
700,000		.0930		
800,000	3,077	.1020		
		.1210		After sustaining load 2 minutes the cube then rapidly yielded under the pressure and went to pieces.

One hour and twenty minutes elapsed from the time the maximum load of the testing machine (800,000 pounds) was first applied and the time of final failure of the cube.

No. 250.

Length, 10″.01.
Compressed surface, 10″×9″.80=98 square inches.
Weight, 77½ pounds.
Total thickness of plaster, ″.10.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
20,000		.0038		
40,000		.0070		
80,000		.0120		
100,000		.0145		
5,000			.0062	
100,000		.0148		
200,000		.0230		
5,000			.0080	
200,000		.0232		
300,000		.0305		
5,000			.0100	
300,000		.0310		
400,000		.0382		
5,000			.0117	
400,000		.0390		
440,000		.0420		
480,000		.0457		
500,000		.0478		
5,000			.0142	
500,000		.0485		
540,000		.0520		
580,000		.0560		
600,000		.0570		
5,000			.0178	
600,000		.0592		
620,000		.0615		
640,000		.0632		
650,500	6,638			Ultimate strength.

Failed suddenly without warning.

After fracture it was found the cube had a stratum of coarser material running across it, parallel to the bed face.

No. 251.

Length, 10''.01.
Compressed surface, 10'' × 9''.96 = 99.60 square inches.
Weight, 78¼ pounds.
Total thickness of plaster, ''.09.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
20,000	....	.0030	....	
40,000	....	.0062	....	
80,000	....	.0115	....	
100,000	....	.0132	....	
5,000	....	....	.0049	
100,000	....	.0137	....	
200,000	....	.0220	....	
5,000	....	....	.0071	
200,000	....	.0225	....	
300,000	....	.0300	....	
5,000	....	....	.0090	
300,000	....	.0305	....	
400,000	....	.0390	....	
5,000	....	....	.0115	
400,000	....	.0390	....	
500,000	....	.0475	....	
5,000	....	....	.0137	
800,000	....	....	....	
5,000	....	....	....	
770,000	....	....	....	Opened seam along one corner.
800,000	8,032	....	....	Test discontinued.

It was thought that another repetition of the maximum load would have caused rupture.

No. 252.

Length, 10''.
Compressed surface, 10'' × 9''.98 = 99.80 square inches.
Total thickness of plaster, ''.09.

Applied load.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
20,000	....	.0040	....	
40,000	....	.0078	....	
80,000	....	.0135	....	
100,000	....	.0157	....	
5,000	....	....	.0062	
100,000	....	.0160	....	
200,000	....	.0250	....	
5,000	....	....	.0085	
200,000	....	.0250	....	
300,000	....	.0325	....	
5,000	....	....	.0110	
300,000	....	.0329	....	
400,000	....	.0412	....	
5,000	....	....	.0132	
400,000	....	.0418	....	
500,000	....	.0520	....	
5,000	....	....	.0170	
644,000	6,453	....	....	Ultimate strength.

Cube had strata of varying coarseness.

No. 253.

Length, 10″.92.
Compressed surface, 11″.05 × 11″.00 = 121.55 square inches.
Weight, 105 pounds.
Total thickness of plaster, ″.12.

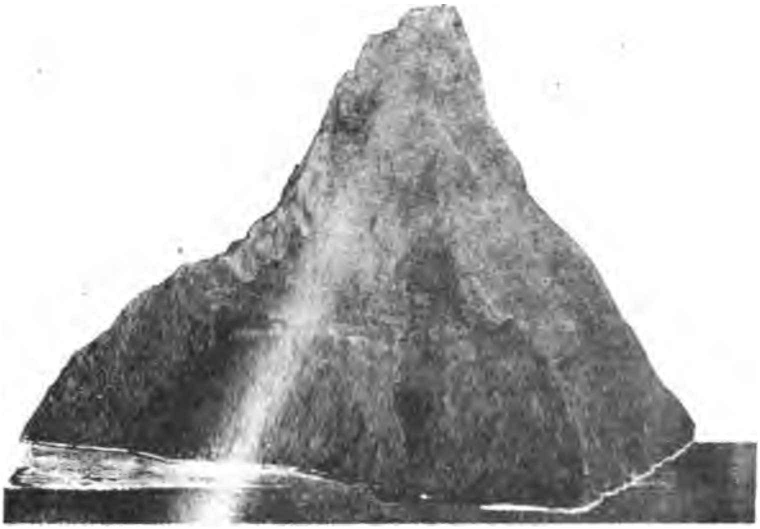
Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
40,000		.0072		
80,000		.0125		
100,000		.0152		
5,000			.0075	
100,000		0154		
200,000		.0260		
5,000			.0120	
200,000		.0262		
300,000		.0340		
5,000			.0152	
300,000		.0350		
400,000		.0412		
5,000			.0175	
400,000		.0417		
500,000		.0485		
5,000			.0193	
500,000		.0492		
600,000		.0562		
5,000			.0220	
600,000		0575		
770,000				Cracked.
791,000	6,508			Ultimate strength.

No. 254.

Length, 11″.01.
Compressed surface, 11″.10 × 10″.96 = 121.66 square inches.
Weight, 106½ pounds.
Total thickness of plaster, ″.07.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000		0.		
40,000		.0072		
80,000		.0122		
100,000		.0145		
5,000			.0060	
100,000		.0150		
200,000		.0240		
5,000			.0062	
200,000		.0242		
300,000		.0308		
5,000			.0105	
300,000		.0312		
400,000		.0380		
5,000			.0120	
400,000		.0380		
500,000		.0450		
5,000			.0140	
500,000		.0455		
600,000		.0530		
5,000			.0155	
600,000		.0540		
770,000				Cracked.
785,000	6,452			Ultimate strength.

PHOTOGRAPH OF 11 INCH CUBE OF HAVERSTRAW FREESTONE No. 256, AFTER THE TEST.



No. 255.

Length, 10″.97.
Compressed surface, 11″.00×11″.00=121″.00 square inches.
Weight, 104½ pounds.
Total thickness of plaster, ″.04.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0081	....	
80,000	....	.0145	....	
100,000	....	.0170	....	
5,000	....	....	.0080	
100,000	....	.0175	....	
200,000	....	.0270	....	
5,000	....	....	.0118	
200,000	....	.0272	....	
300,000	....	.0350	....	
5,000	....	....	.0140	
300,000	....	.0350	....	
400,000	....	.0420	....	
5,000	....	....	.0160	
400,000	....	.0425	....	
500,000	....	.0500	....	
5,000	....	....	.0178	
500,000	....	.0507	....	
600,000	....	.0575	....	
5,000	....	....	.0210	
600,000	....	.0580	....	
778,000	....	....	....	Cracked.
779,200	6,440	....	....	Ultimate strength.

No. 256.

Length, 11″.02.
Compressed surface, 11″.10×11″.05=122.65 square inches.
Weight, 106½ pounds.
Total thickness of plaster, ″.14.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0065	....	
80,000	....	.0120	....	
100,000	....	.0140	....	
5,000	....	....	.0052	
100,000	....	.0140	....	
200,000	....	.0228	....	
5,000	....	....	.0078	
200,000	....	.0230	....	
300,000	....	.0300	....	
5,000	....	....	.0099	
300,000	....	.0310	....	
400,000	....	.0388	....	
5,000	....	....	.0182	
400,000	....	.0392	....	
500,000	....	.0500	....	
5,000	....	....	.0180	
500,000	....	.0510	....	
600,000	....	.0600	....	
5,000	....	....	.0220	
600,000	....	.0615	....	
769,000	6,270	....	....	Ultimate strength.

No. 257.

Length, 12''.01.
Compressed surface, 12''.00 × 11''.95 = 143.40 square inches.
Weight, 139½ pounds.
Total thickness of plaster, .04.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,600	....	.0095	....	
80,000	....	.0160	....	
100,000	....	.0185	....	
5,000	....	....	.0085	
100,000	....	.0192	....	
200,000	....	.0232	....	
5,000	....	....	.0115	
200,000	....	.0288	....	
300,000	....	.0355	....	
5,000	....	....	.0135	
300,000	....	.0360	....	
400,000	....	.0420	....	
5,000	....	....	.0150	
400,000	....	.0425	....	
500,000	....	.0487	....	
5,000	....	....	.0170	
500,000	....	.0492	....	
600,000	....	.0555	....	
5,000	....	....	.0188	
600,000	....	.0560	....	
700,000	....	.0630	....	
5,000	....	....	.0202	
700,000	....	.0632	....	
800,000	5,579	.0690	....	Cube did not fracture. Tested in a pier. See No. 260½.
5,000	....	....	.0225	

No. 258.

Length, 12″.04.
Compressed surface, 12″.00×12″.00=144.00 square inches.
Weight, 138 pounds.
Total thickness of plaster, ″.19.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0060	....	
80,000	....	.0110	....	
100,000	....	.0180	....	
5,000	....	....	.0050	
100,000	....	.0180	....	
200,000	....	.0205	....	
5,000	....	....	.0070	
200,000	....	.0210	....	
300,000	....	.0265	....	
5,000	....	....	.0062	
300,000	....	.0270	....	
400,000	....	.0320	....	
5,000	....	....	.0098	
400,000	....	.0330	....	
500,000	....	.0370	....	
5,000	....	....	.0110	
500,000	....	.0370	....	
600,000	....	.0430	....	
5,000	....	....	.0128	
600,000	....	.0440	....	
700,000	....	.0500	....	
5,000	....	....	.0150	
700,000	....	.0510	....	
800,000	5,556	.0585	....	Cube did not fracture. Teste in a see No. 260½.
5,000	....	....	.0180	
....	....	....	.0172	After one hour rest.

No. 80.

12″ brick pier, with bluestone cap and base.

Total height, 22″.58.
Thickness of bluestone—cap, 2″.75; base, 3″.50.
Weight of brick-work, 154 pounds.
Weight per cubic foot, 113 pounds.
Sectional area, 12″×12″=144 square inches.
Gauged length, 22″.58.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0035	....	
20,000	....	.0080	....	
30,000	....	.0102	....	
40,000	....	.0125	....	
50,000	....	.0150	....	
5,000	....	....	.0042	
50,000	....	.0153	....	
60,000	....	.0170	....	
70,000	....	.0192	....	
80,000	....	.0210	....	
90,000	....	.0230	....	
100,000	....	.0252	....	
5,000	....	....	.0062	
100,000	....	.0260	....	
110,000	....	.0280	....	
120,000	....	.0298	....	
130,000	....	.0320	....	
140,000	....	.0360	....	Snapping sounds; no cracks in sight.
150,000	....	.0390	....	
5,000	....	....	.0112	
150,000	....	.0402	....	
160,000	....	.0428	....	
170,000	....	.0450	....	
180,000	....	.0480	....	
190,000	....	.0522	....	
200,000	....	.0565	....	Cracks in sight in three courses.
5,000	....	....	.0168	
200,000	....	.0590	....	
210,000	....	.0620	....	
220,000	....	.0662	....	
230,000	....	.0720	....	
240,000	....	.0790	....	
250,000	....	.0880	....	
260,000	1,806	.1030	....	Ultimate strength.

No. 260½.

[Supplementary test of 12" cubes, Nos. 257, 258, and 260. Tested as a pier.]

Length, 36".06.
Sectional area, 143.24 square inches.
Total thickness of plaster, ".36.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
40,000	....	.0210	....	
80,000	....	.0350	....	
100,000	....	.0415	....	
5,000	....	....	.0025	
100,000	....	.0422	....	
200,000	....	.0638	....	
5,000	....	....	.0042	
200,000	....	.0638	....	
300,000	....	.0805	....	
5,000	....	....	.0060	
300,000	....	.0805	....	
400,000	....	.0942	....	
5,000	....	....	.0080	
400,000	....	.0948	....	
500,000	....	.1075	....	
5,000	....	....	.0095	
500,000	....	.1080	....	
600,000	....	.1210	....	
5,000	....	....	.0112	
600,000	....	.1220	....	
700,000	....	.1370	....	
5,000	....	....	.0150	
700,000	....	.1400	....	Crack A in sight.
748,000	5,222	....	....	Ultimate strength.

Failed suddenly under the maximum pressure, with a loud report.

There was slight warning at 745,000 pounds pressure of approaching failure, as indicated by more rapid compression of the pier.

No. 83.

12″ brick pier with bluestone cap and base.

Total height, 21″.98.
Thickness of bluestone—cap, 3″.00; base, 3″.10.
Weight of brick work, 147 pounds.
Weight per cubic foot, 113 pounds.
Sectional area, 11″.75×12″.00=141 square inches.
Gauged length, 21″.98.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
5,000	....	0.	....	
10,000	....	.0030	....	
20,000	....	.0060	....	
30,000	....	.0080	....	
40,000	....	.0102	....	
50,000	....	.0120	....	
5,000	....	....	.0022	
50,000	....	.0120	....	
60,000	....	.0140	....	
70,000	....	.0160	....	
80,000	....	.0180	....	
90,000	....	.0205	....	
100,000	....	.0225	....	
5,000	....	....	.0040	
100,000	....	.0235	....	
110,000	....	.0252	....	
120,000	....	.0275	....	
130,000	....	.0302	....	
140,000	....	.0330	....	
150,000	....	.0360	....	
5,000	....	....	.0080	
150,000	....	.0372	....	Cracks started in second course of bricks.
160,000	....	.0400	....	
170,000	....	.0432	....	
180,000	....	.0470	....	
190,000	....	.0510	....	
200,000	....	.0550	....	
5,000	....	....	0.148	
200,000	....	.0590	....	
210,000	....	.0632	....	
220,000	....	.0700	....	
230,000	....	.0760	....	
240,000	....	.0870	....	
250,000	....	.0990	....	
251,000	1,780	.1090	....	Ultimate strength.

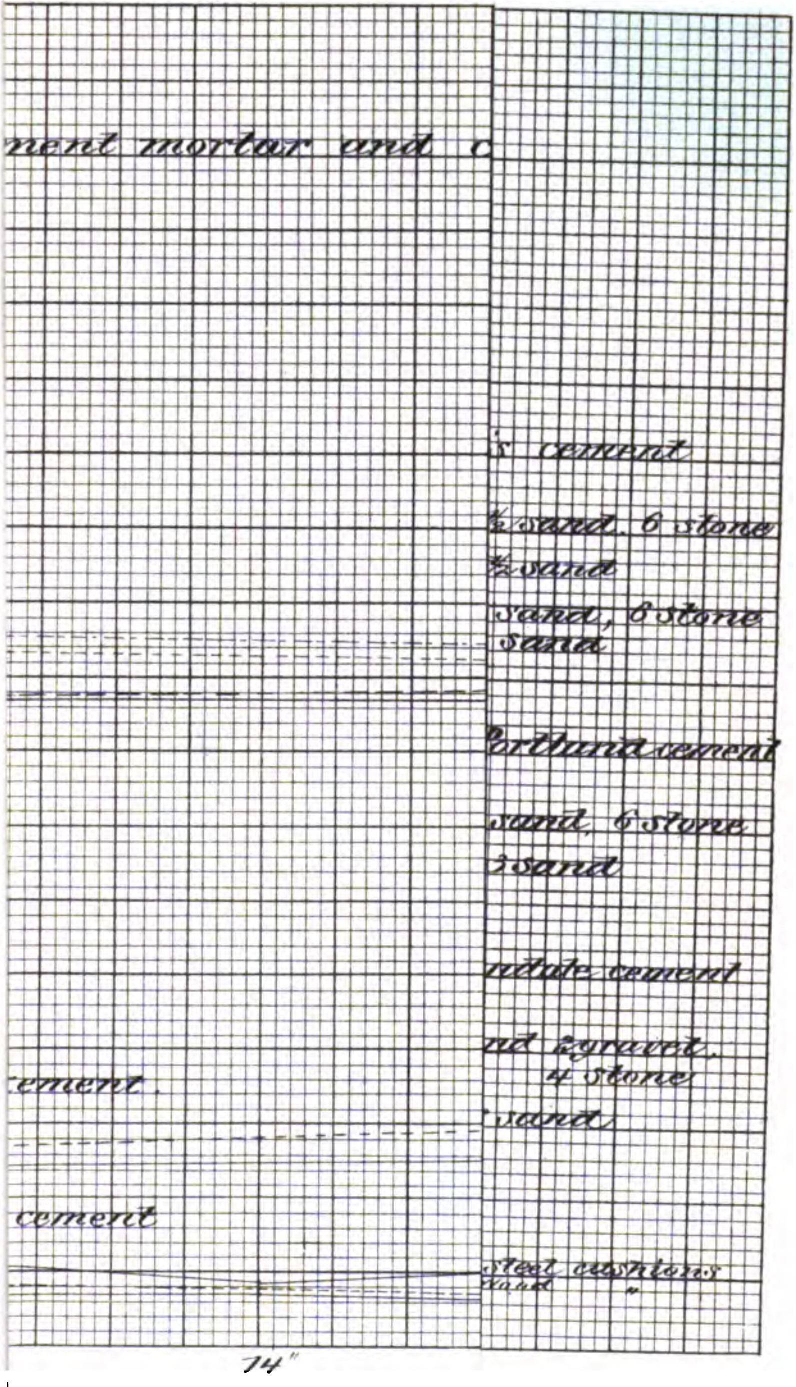
DIAGRAMS OF COMPRESSIVE STRENGTH

OF

CEMENT, MORTAR, CONCRETE, AND FREESTONE CUBES AND PRISMS.

f cubes and prisms

ement.


nent mortar and c
's cement
½ sand, 6 stone
½ sand
sand, 6 stone
sand
Portland cement
sand, 6 stone
3 sand
ntate cement
nd 2 gravel,
4 stone
cement.
sand
cement
steel cushions
Wood
"
14"

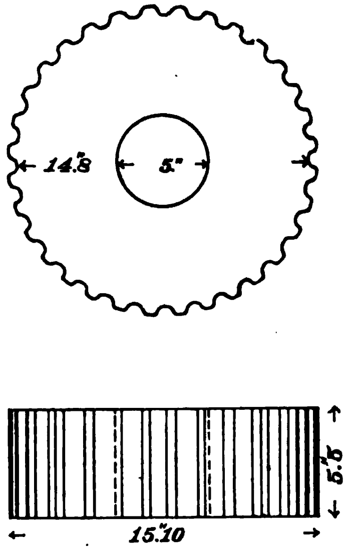
bes and prisms

7.—COMPRESSION OF TERRA COTTA.

[For General M. C. Meigs, Supervising Engineer and Architect, Washington, D. C.]

No. 1.

Form of specimen, with approximate dimensions.



Light colored block.

Weight, 64½ pounds.

Sectional area (approximate), 156 square inches.

Tested between white-pine cushions 2″ thick, made of inch boards, with the grain crossing.

At 28,000 pounds load, cracks opened at one edge.

Ultimate strength, 535,400 pounds = 3,432 pounds per square inch.

The cracks observed at 28,000 pounds did not increase in length as loads were added, till 300,000 pounds had been reached. At this time the block was very generally shelling off at the edges.

From 300,000 pounds to the maximum load, failure in detail was continually going on.

No. 2.

[Same form as No. 1.]

Dimensions of block.

Outside diameter	inches..	15.80
Diameter at bottom of fluting	do....	15.50
Diameter of core	do....	5.00
Length	do....	5.55
Weight	pounds..	68½
Sectional area (approximate)	square inches..	173

Tested between 2″ pine cushions, in the same manner as No. 1.

At 47,000 pounds pressure a surface fire crack was enlarged, and extended along the length of the block.

Ultimate strength, 592,300 pounds = 3,424 pounds per square inch.

No decided injury to the block was apparent till about 400,000 pounds pressure was reached, when it began to flake off at edges.

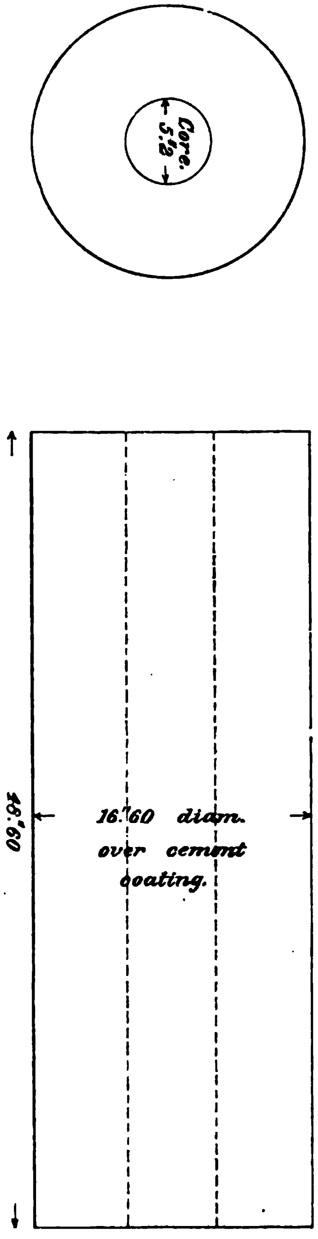
Under 480,000 pounds there was sudden yielding, which it immediately recovered from; with this exception, the disintegration of the block proceeded gradually till the maximum load was reached.

No. 13.

TERRA COTTA COLUMN.

Column composed of eight terra cotta sections, each about 5½″ long, and with fluted outside surface, the outside diameter of the terra cotta being about 15½″. These sections were cemented together and covered with cement, making the total external diameter 16″.60.

Form of specimen.



Weight, 671 pounds.

Sectional area (gross), 195.18 square inches.

The ends of the post were fitted with circular cast-iron plates 1⅛ inches thick, 16.60 inches diameter. The outer faces of the cast-iron plates were convex about one-tenth of an inch.

To secure a better distribution of load, brass packing was used between the cast-iron plates and the flat compression platforms of the testing-machine.

Compression measurements were taken in 30 inches gauged length, equidistant from the ends of the post.

Nails driven into the cement shell afforded a resting place for the points of the micrometer gauge.

Applied loads.		Compression.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
10,000		0.		
20,000		.0010		
30,000		.0020		
40,000		.0034		
50,000		.0049		
10,000			.0004	
60,000		.0064		
70,000		.0082		
80,000		.0100		
90,000		.0115		
100,000		.0138		
10,000			.0012	
110,000		.0165		
120,000		.0188		
130.000		.0215		
140.000		.0243		
145,000				Cement covering flaked off 15 per cent. of surface of terra cotta, micrometer disturbed.
172,000	881			Ultimate strength. Cement covering continued to flake off, exposing to view longitudinal cracks in the terra cotta sections.

Pressure continued, longitudinal seams opening in the terra cotta sections, while the load gradually fell to 160,000 pounds, when the test was discontinued.

8.—CAST IRON, STEEL, AND BRONZE.

GUN SPECIMENS.

Steel from jacket band and trunnion ring for 3''.2 gun.

Cast iron from trial-cylinder for 12'' mortar.

Cast iron from 12'' mortar.

Steel from hoops for 12'' mortar.

Steel from tube for 8'' breech-loading rifle.

Steel from hoops for 8'' breech-loading rifle.

Steel (Whitworth) from tube of Mann gun.

Cast-iron from breech disc 10'' wire-wound gun.

The following kinds of tests have been made: Tension, compression, crushing, transverse, tangential or bursting and hardness.

The tensile specimens were cylindrical, with the exception of four rectangular bars taken from 12-inch mortar hoop BEX.

The cylindrical bars had threaded ends for securing them in dies, which dies were clamped in the hydraulic jaws of the testing machine.

Their lengths given in the details of the tests are for the parts cylindrical, or from neck to neck.

Rectangular bars were clamped directly in the hydraulic jaws.

Micrometer readings were taken of the elongations and sets within the gauged length, or the distance from neck to neck of the specimen. These readings were recorded in ten thousandths of an inch. When near the close of a test the micrometer was removed, to avoid injury when the bar broke. The elongations from this point to the close of the test were taken with common dividers, measuring to the nearest hundredth of an inch. In the report these measurements are reduced to elongations and sets per linear inch of the specimen.

In a similar manner micrometer readings were taken of the compression specimens; in this case employing a gauged length from one to two inches shorter than the length of the specimen.

The transverse bars were supported at the ends, and loaded at the middle. Deflections and deflection sets were taken at the middle of the bar, and are reported as they were measured in ten thousandths of an inch.

The modulus of rupture for cylindrical bars was computed by the formula $R=\frac{Pl}{\pi r^3}$

Where P=load in pounds.
l=length in inches between supports.
π=3''.1416.
r=radius in inches.

The tangential or bursting tests were made with cylinders 5'' long, 3'' outside diameter, and 1'' bore.

They were tested in the attachment, of which a drawing is shown. This attachment consists of a reservoir and piston, three studs, and a base plate.

The reservoir is mounted over, and held at a fixed distance from the base plate by the studs. Between the reservoir and base plate is placed the test cylinder. Cylindrical projections enter the bore of the test cylinder at either end; that from the reservoir is perforated with a $\frac{3}{16}''$ hole, $2\frac{1}{2}''$ long, through which communication is established with the reservoir chamber and the bore of the test cylinder. The plug at the opposite end is solid.

Both cylinder and reservoir are charged with the straining fluid. The piston of the reservoir is loaded, and forces the straining fluid through the $\frac{3}{16}''$ hole into the cylinder. By employing a straining fluid capable of perfect transmission of pressure, the pressure which acts upon the piston will be the pressure in the reservoir chamber, also in the test cylinder less the amount of the packing friction of the piston.

The attachment, it is seen, keeps the length of cylinder under pressure constant throughout the test.

The hardness of the metal is determined by means of the indenting tool, shown by the drawing, employing indenting pressures of 10,000 pounds, according to the method thus described by Major Wade, U. S. A., in his report on the strength and properties of metals in the manufacture of cannon:

"The comparative softness or hardness of metals is determined by the bulk of the cavities or indentations made by equal pressures; the softness being as the bulk directly, and the hardness as the bulk inversely.

"The form of the indenting part of the tool is a pyramid; the sides and opposite angles of its base are equal. The longest diagonal of its base is 1 inch; the shortest .2; and the height of the pyramid is .1. The planes of the sides intersect, at the penetrating edge, at an angle of 90°. The unit of measure adopted in representing the indentations is one-tenth of an inch.

"The area of the base of the indenting tool $=\frac{10\times 2}{2}=10$ square tenths, and its height being 1, the cubic content of the pyramid is 3.333 tenths. A pressure of 10,000 pounds on the base of the pyramid makes an indentation, in the softest metals used in guns, about 9 tenths long. The maximum indentation of the instrument, $3\frac{1}{3}$ cubic tenths, is therefore assumed as the type of extreme softness, and is the 0 of hardness."

"*Example of the method of computation.*

"Length of indentation $=7.5$.

"Then, as length $10^3 : 3.333 :: (7.5)^3 : 1.406 =$ bulk; and, inversely, $(7.5^3) : 3.333 :: 10^3 : 7.901 =$ hardness.

"Or, by logarithms:

"For bulk, 3.333	log..	0.5228787
Divided by $10^3=1000$	log..	3.0000000
Constant log. for bulk		3.5228787
Length of indentation $(7.5)^3$	log..	2.6251839
Bulk=1.406		0.1480626
For hardness, 10^3	log..	3.0000000
Multiplied by 3.333		0.5228787
Constant log. for hardness		3.5228787
Divided by length (7.5^3)	log..	2.6251839
Hardness=7.901		0.8976948"

The discrepancy between Major Wade's description of this method of determining hardness and his examples of the method of computation will be readily seen.

The hardness of specimens given in this report follows the examples given, hence the results are comparable with earlier tests.

The behavior of the metal in 12″ mortar hoop Bex; requires special comment.

From this hoop were cut three rings, and small cylindrical specimens taken from each; also from the first and second rings larger rectangular bars were obtained. Advantage was taken of the size of the rectangular bars, and their tests were made in a more exhaustive manner than is possible with small specimens.

The preparation of the rectangular bars was as follows:

After the small specimens M. Bex 1, 2, 3, and 4, and M. Bex 5 and 6 were cut out, the remaining (nearly semicircular) pieces, which made the rectangular test pieces, were heated light red (no scale), and straightened under pressure; and bars Nos. 111 and 112, marked R. T., in addition to other distinguishing marks, were retempered and annealed.

The bars were dressed in the planer to the finished sizes. The central section of each was reduced in width a length of 30″; on this 30″ section were placed three micrometers; one instrument covering the entire length, one covering 10″ from the neck towards the middle of the bar, and one covering 15″ from the opposite neck towards the middle of the bar.

In this manner the bar was divided into three sections of 5, 10, and 15″ length, and the elongation in each of these sections determined.

It seldom happens that a metal is found so nearly uniform in strength that there is no appreciable difference in the elastic limit of one section over another in the same bar.

By means of micrometer measurements on different sections this behavior can be shown. Examining the record of each bar we find that specimen No. 110, which had been straightened hot, but not retempered and annealed, passed the elastic limit of section A (30″) at 45,000 pounds per square inch. The total permanent set after this load was, ″.0005 in 30″, and of this amount ″.0002 was confined to section C (15″), and none in section B (10″); hence ″.0003 was in the 5″ section between sections B and C, in the immediate locality where fracture finally occurred.

At 47,000 pounds per square inch, the stretching had extended into section C, and the elastic limit of that part of the bar was then passed. At 49,000 pounds per square inch, the elastic limit of section B was reached.

Under 50,000 pounds per square inch tension, the rapid stretching which had previously been extending into section C, now changed its direction and took place more rapidly in section B.

The total permanent sets are now—

	Inch.
Section A	.1121
Section B	.0455
Section C	.0331

5″ section between B and C, by difference ″.0335.

This disposition to stretch most in the vicinity of where the bar afterwards fractured continued through the test.

The contracted areas, measured after 70,000 pounds per square inch tension, are in harmony with the elongation measurements, in showing the maximum contraction and elongation are confined to the same section of bar.

Longitudinally this bar is seen to vary in strength; bars are also met which vary in strength in their transverse section, examples of which are found in the manner of failure of bar No. 111, and also in the behavior of bar No. 112 during the test.

The appearance of the fracture of bar No. 110 is granular, radiating from a dull smoky-colored center. Generally, although not invariably, when a steel bar fractures with a radiated appearance, the center of radiation marks the point where the fracture began.

Test of bar No. 111.

This bar was straightened hot, then retempered and annealed.

Elongations were taken with three micrometers as in the preceding test. The elastic limit was first passed in section C, at 40,000 pounds per square inch; increasing the load the metal in this section was stretched 1.2 per cent. at 41,400 pounds per square inch, when the elastic limit of section B was reached.

The load on the bar was increased to 41,690 pounds per square inch, which it sustained a period of 3 minutes, stretching in section B gradually going on in the mean time; then the load suddenly fell to 39,070 pounds per square inch, as stretching proceeded rapidly. The elongation had now reached .31 per cent. in section B, while the metal in section C remained practically unchanged.

Stretching continued under reduced loads, and when 41,690 pounds per square inch was again reached the stretch was .5 per cent.

It will be observed that the metal in section C has stretched over twice and a half the amount of the stretch in section B, and yet did not develop the peculiar behavior of the latter section.

The metal in each section continued to elongate until 45,000 pounds per square inch tension was reached, when the metal in section B again elongated rapidly, accompanied by a sudden fall of the load to 43,140 pounds per square inch. After recovering from this fall in load, the stretch was regular for the remainder of the test.

The contraction after 60,000 pounds per square inch, is seen to range from 2.9 to 3.8 per cent. at different points.

The bar fractured in section C, where rapid stretching first took place.

The manner of failure showed the strength of the bar to vary in its transverse section, as fracture began at one edge (the inner edge of the hoop) and gradually separated about one-third the metal, which had a fine silky appearance; the balance of the fracture took place suddenly, and had a granular appearance, radiating from the silky portion of the fractured surface.

The metal along the silky edge stretched ″.10 less before rupture than the opposite edge.

Test of bar No. 112.

This bar was straightened hot, then retempered and annealed.

Elongations were taken with three micrometers, as in the preceding test.

The elastic limit of section A was passed at 41,000 pounds per square inch, the elastic limit of section B at 42,000 pounds per square inch.

The load now fell to 38,526 pounds per square inch, while rapid stretching took place in section B; thus showing the behavior observed in the other retempered annealed bar.

When the load had recovered to 42,000 pounds per square inch the elastic limit of section C was passed. Increasing the load 1,000 pounds, to 43,000 pounds per square inch, the load fell a second time. On this occasion the rapid stretching occurred in section C.

The load was increased to 46,000 pounds per square inch, when it again fell, going to 43,230 pounds per square inch, from which it recovered to 43.480 pounds per square inch, and again fell off to 42,510 pounds per square inch, the metal in section B yielding on these, the third and fourth occasions.

The remainder of the test was not marked by further behavior of this kind. Another peculiarity, however, was shown. The stem did not draw straight between the heads of the bar during the progress of the test with loads above the elastic limit, notwithstanding the heads were rigidly clamped in the jaws of the testing machine, so that no movements at the ends occurred.

The bar was examined after the first rapid stretch had taken place and the load had recovered to 40,100 pounds per square inch. It was now concave ″.005 along the inside edge (D E) of the hoop.

After the second rapid stretch, and while sustaining 40,340 pounds per square inch, the stem was again examined, and now found concave along the inside edge at end B and convex along the same edge at end C.

Sectional areas and ordinates were measured after the fourth fall of the load. The contraction of area was greatest at end B, near the neck, no contraction having yet taken place at the middle of the stem. This contraction at the ends would make the bar appear convex on all its faces, if otherwise uninfluenced.

The ordinates show the bar sufficiently out of line to counteract the influence of unequal contraction and make it concave along the outside edge of the hoop, and also show the distortion took place unequally along the different lines.

From this time till the close of the test the points of maximum convexity and contrary flexure were observed to shift their position along the length of the stem, as the metal in one part of the bar yielded more readily than adjacent portions.

Test of bar No. 113.

This bar was straightened hot, but not retempered and annealed.

The elastic limits of the different sections were as follows:

	Pounds per square inch.
Section A	47,000
Section B	50,000
Section C	50,000

This bar developed the same peculiarities just before its rupture which were observed in the retempered and annealed bars immediately after they had passed their elastic limits; *i. e.*, the load would fall and the bar continue to stretch under loads below that which it had previously sustained.

Remarks on the tangential test of cast-iron cylinder XI, page ——.

The first test of the cylinder was made with a mixture of beeswax 4, tallow 1, as the straining fluid.

The total volume used was 6.71 cubic inches, of which 3.06 cubic inches were in the bore of the test cylinder and 3.65 cubic inches in the reservoir chamber.

Loads were gradually applied to the piston and its movement measured as it entered the reservoir; also the expansion of the external diameters of the cylinder for each increment of load.

The diameters were taken in one plane and at intervals of 1″.

With 10,000 pounds per square inch on the piston the middle diameters of the cylinder were perceptibly larger. This enlargement of diameters continued as higher pressures were applied, but in a manner indicating there was not perfect transmission of pressure from the reservoir to the cylinder.

The diameters should have increased more rapidly as the elastic limit of the cast iron was passed, but up to 30,000 pounds per square inch on the piston the maximum enlargement of diameter only reached ″.0018.

Under higher pressure the cylinder was covered with canvas, and removed when returning to the initial load for the purpose of determining the permanent sets. 102,910 pounds per square inch were applied to the reservoir piston, causing a permanent set in the cylinder at the middle diameter of ″.0021. At the reservoir end the diameter was increased ″.0005, while at the lower end there was no appreciable expansion.

The cylinder was removed from the attachment and the $\frac{3}{16}$″ hole at the bottom of the reservoir chamber sealed.

The piston was then loaded and its movement measured.

Comparing the piston movement with both chambers in communication, and with the reservoir alone, we form this table.

Loads per square inch on piston.	Piston movement with—			
	Reservoir and cylinder connected.		Reservoir alone.	
	Total movement.	Successive movement.	Total movement.	Successive movement.
	Inch.	*Inch.*	*Inch.*	*Inch.*
1,000	0.	0.	0.	0.
10,000	.145	.145	.060	.060
15,000	.230	.085	.100	.040
20,000	.275	.045	.130	.030
30,000	.360	.085	.180	.050
40,000	.420	.060	.230	.650
50,000	.470	.050	.270	.040
60,000	.520	.050	....	....
77,610	.590	.070	....	....

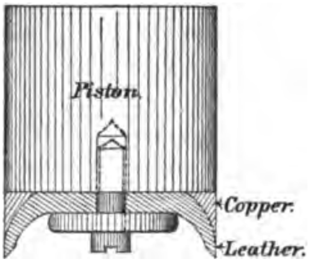
The successive piston movements when reservoir and cylinder are connected show a decided change at 30,000 pounds per square inch. From this load onward the rate of movement corresponds closely with the piston movement when the reservoir alone was used.

The piston movement in the latter case represents chiefly the compression of the wax and tallow, and from the correspondence in piston movement, it is inferred that the flow of wax through the $\frac{3}{16}$ inch aperture from reservoir to cylinder nearly ceased with a load between 30,000 and 40,000 pounds per square inch on the piston; and although over 100,000 pounds per square inch was applied, the wax refused to flow through the $\frac{3}{16}$ inch hole when the difference in pressure at the two ends amounted to about 60,000 pounds per square inch.

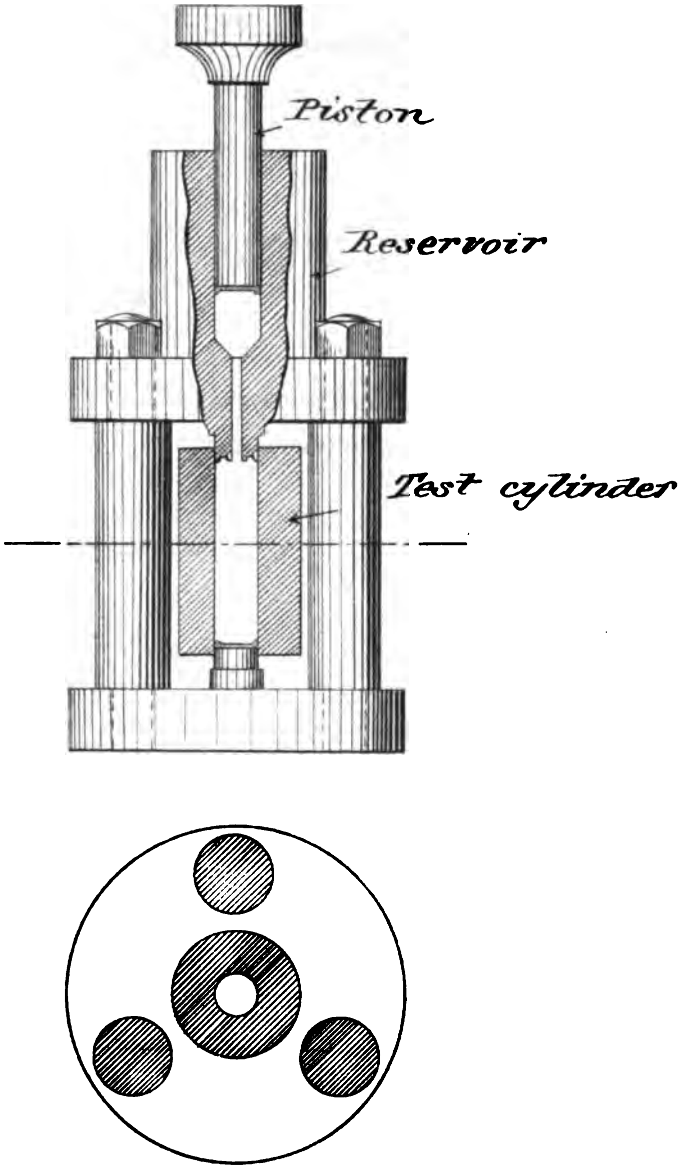
That the wax did not transmit the pressure beyond a certain amount, is further shown by the behavior of the cylinder when charged with water. A pressure of 37,210 pounds per square inch was applied, which caused a permanent set in diameter of ″.0034, against the permanent set of ".0021 when wax was used, with 102,910 pounds per square inch on the piston.

Copper checks, with the lips brought to a thin edge, made good joints when wax and tallow was used in the cylinders. Leather cup-shaped packings, re enforced with copper checks, were employed for sealing water, oil, and glycerine.

Leather alone was found capable of sealing water under pressures above 78,000 pounds per square inch on a piston closely fitting the bore of a stout cylinder. When the cylinder is to be strained beyond its elastic limit, a copper check of triangular cross-section placed behind the leather (as shown by the sketch) proved effectual in preventing the leather packing from blowing out.



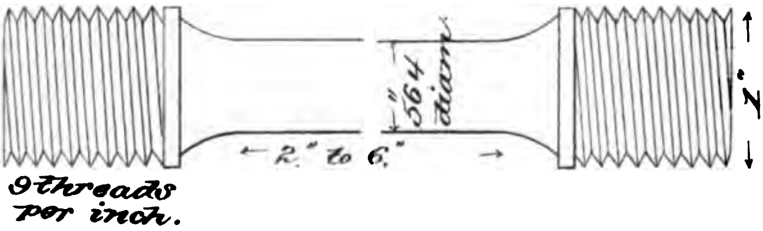
Attachment for tangential tests of cylinders.



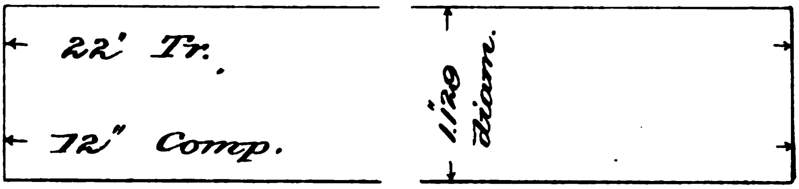
Form of specimens.

Steel

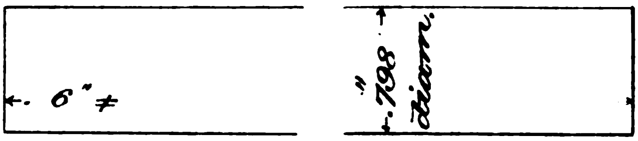
Tension



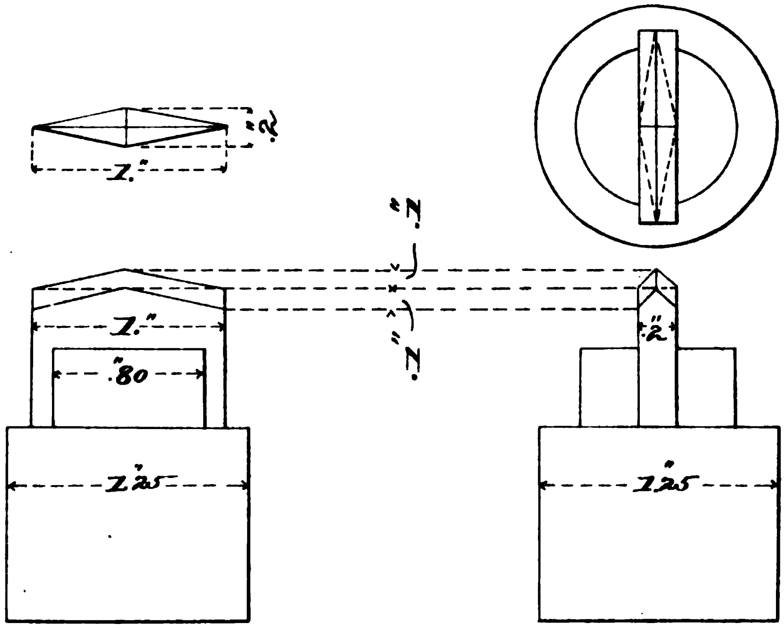
Transverse and Compression



Compression.



Indenting Tool for hardness tests.



S Ex 35 491

STEEL FROM JACKET, BAND, AND TRUNNION RING FOR 3″.02 GUN FROM MIDVALE STEEL WORKS.

MANNER OF PREPARING SPECIMENS.

A ring 1¼ inches thick was cut from one end of the jacket.

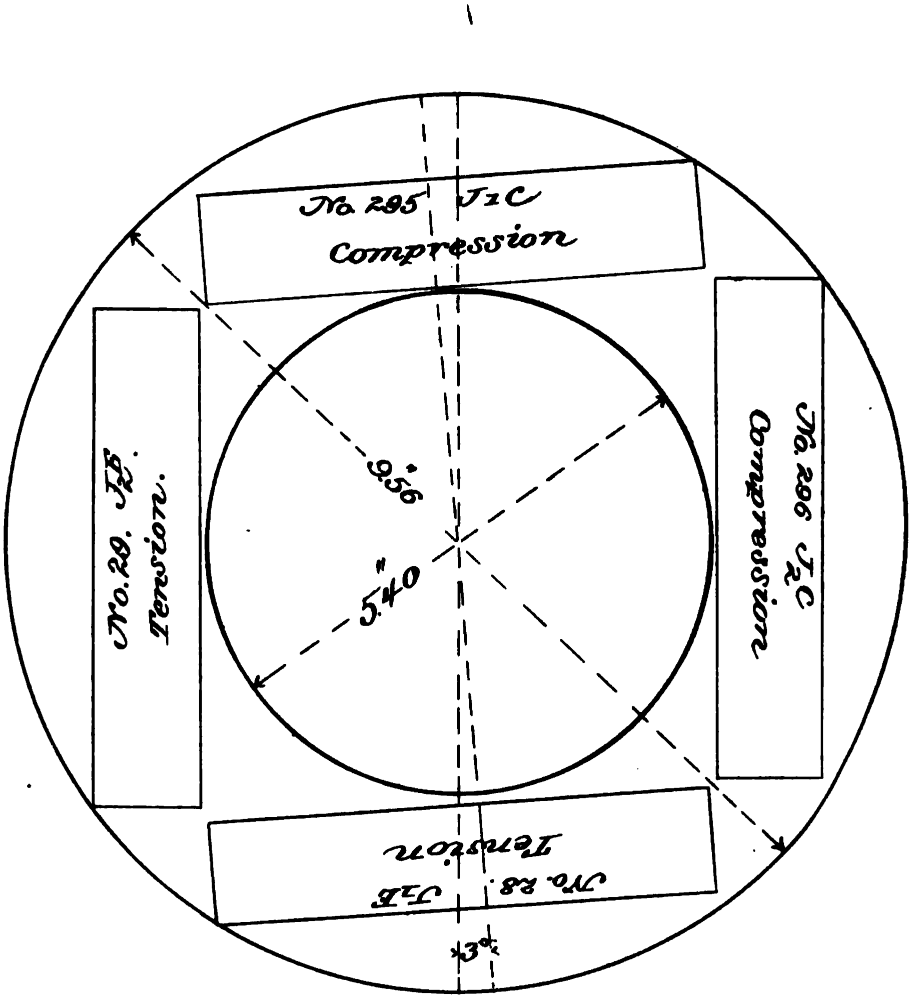
From this ring were planed four pieces 1⅛ inches square by 5¼ inches long. Their location is shown on the following diagram.

From these pieces were turned two samples for tension and two for compression.

The tension specimens were allowed to remain 5¼ inches long, the excess over 5 inches being added to the shoulder next the screw portion. They were marked ${}^{J}{}_{1}^{E}$ and ${}^{J}{}_{2}^{E}$.

The compression specimens were turned cylindrical, ″.798 diameter by 5 inches long. The lathe center marks were carefully removed. They were marked ${}^{J}{}_{1}^{C}$ and ${}^{J}{}_{2}^{C}$.

Ring from Jacket, 3.2 inch Gun.



S Ex 35 49 1

No. 28.

Tension test.

Marks on specimen J^1E
Length, 2″.00.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	
1,250	5,000	0.	....	....	....	
2,500	10,000	.0005	.0005	....	....	
2,750	11,000	.0005	0.	....	....	
3,000	12,000	.0005	0.	....	....	
3,250	13,000	.0005	0.	....	....	
3,500	14,000	.0005	0.	....	....	
3,750	15,000	.0007	.0002	....	....	
4,000	16,000	.0007	0.	.....	....	
4,250	17,000	.0007	0.	....	....	
4,500	18,000	.0007	0.	....	....	
4,750	19,000	.0007	0.	....	....	
5,000	20,000	.0007	0.	....	....	
5,250	21,000	.0007	0.	....	....	
5,500	22,000	.0007	0.	....	....	
5,750	23,000	.0007	0.	....	....	
6,000	24,000	.0010	.0003	....	......	
6,250	25,000	.0010	0.	....	....	
6,500	26,000	.0010	0.	....	....	
6,750	27,000	.0010	0.	....	....	
7,000	28,000	.0010	0.	....	....	
7,250	29,000	.0010	0.	....	....	
7,500	30,000	.0010	0.	....	....	
7,750	31,000	.0012	.0002	....	....	
8,000	32,000	.0012	0.	....	......	
8,250	33,000	.0012	0.	....	....	
8,500	34,000	.0012	0.	....	....	
8,750	35,000	.0012	0.	....	....	
9,000	36,000	.0012	0.	....	....	
9,250	37,000	.0015	.0003	....	....	
9,500	38,000	.0015	0.	....	....	
9,750	39,000	.0015	0.	....	....	
10,000	40,000	.0015	0.	....	....	
250	1,000	....	....	0.	....	
10,250	41,000	.0015	0.	....	....	
10,500	42,000	.0015	0.	....	....	
10,750	43,000	.0015	0.	......	....	
11,000	44,000	.0017	.0002	....	....	
11,250	45,000	.0017	0.	....	....	
11,500	46,000	.0017	0.	....	....	
11,750	47,000	.0017	0.	....	....	
12,000	48,000	.0017	0.	......	....	
12,250	49,000	.0020	.0003	....	....	
12,500	50,000	.0020	0.	....	....	
250	1,000	....	....	0.	....	
12,750	51,000	.0020	0.	....	....	
13,000	52,000	.0020	0.	....	....	
13,250	53,000	.0020	0.	....	....	
13,500	54,000	.0022	.0002	.....	....	Elastic limit.
13,750	55,000	.0027	.0005	....	....	
14,000	56,000	.0035	.0008	....	....	
14,250	57,000	.0040	.0005	....	....	
14,500	58,000	.0045	.0005	....	....	
14,750	59,000	.0050	.0005	....	....	
15,000	60,000	.0060	.0010	....	....	
250	1,000	....	....	.0035	.0035	
15,250	61,000	.0070	.0010	....	....	
15,500	62,000	.0080	.0010	....	....	
15,750	63,000	.0085	.0005	....	....	
16,000	64,000	.0095	.0010	....	....	
16,250	65,000	.0100	.0005	....	....	
16,500	66,000	.0110	.0010	....	....	
16,750	67,000	.0120	.0010	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
17,000	68,000	.0130	.0010	....	....	
17,250	69,000	.0140	.0010	....	....	
17,500	70,000	.0150	.0010	....	....	
18,000	72,000	.0165	.0015	....	....	
18,500	74,000	.0185	.0020	....	....	
19,000	76,000	.0210	.0025	....	....	
19,500	78,000	.0235	.0025	....	....	
20,000	80,000	.0255	.0020	....	....	
250	1,000	....	....	.0215	.0180	
20,500	82,000	.0285	.0030	....	....	
21,000	84,000	.0310	.0025	....	....	
21,500	86,000	.0345	.0035	....	....	
22,000	88,000	.0385	.0040	....	....	
22,500	90,000	.0415	.0030	....	....	
23,000	92,000	.0465	.0050	....	....	
23,500	94,000	.0515	.0050	....	....	
24,000	96,000	.0570	.0055	....	....	
24,500	98,000	.0655	.0085	....	....	
25,000	100,000	.0780	.0125	....	....	
25,500	102,000	.1130	.0350	....	....	Ultimate strength.
0	0	.1300	....	....	....	Elongation after fracture.

General summary.

Tensile strength per square inch of original section	pounds..	102,000
Elastic limit per square inch of original section	do....	54,000
Elongation per inch after rupture	inch..	0.1300
Elongation per inch under strain at elastic limit	do...	.0022
Reduction in diameter at point of rupture	do...	.064
Reduction in area after rupture, per centum of original section		21.6
Position of rupture		".75 from curve of neck.
Character of broken surface		granular, 80 per cent.; dull smoky spot, 20 per cent.

No. 29.

Tension test.

Marks on specimen, J_2 E
Length, 2".00
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	
1,250	5,000	0.	....	....	....	
2,500	10,000	.0002	.0002	....	....	
3,750	15,000	.0005	.0003	....	....	
5,000	20,000	.0005	0.	....	....	
6,250	25,000	.0007	.0002	....	....	
7,500	30,000	.0010	.0003	....	....	
8,750	35,000	.0012	.0002	....	....	
10,000	40,000	.0015	.0003	....	....	
250	1,000	....	....	.0	....	
10,250	41,000	.0015	0.	....	....	
10,500	42,000	.0017	.0002	....	....	
10,750	43,000	.0020	.0003	....	....	
11,000	44,000	.0020	0.	....	....	
11,250	45,000	.0020	0.	....	....	
11,500	46,000	.0020	0.	....	....	
11,750	47,000	.0022	.0002	....	....	
12,000	48,000	.0022	0.	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
12,250	49,000	.0022	0.	....	....	
12,500	50,000	.0022	0.	....	....	
250	1,000	....	....	.0	....	
12,750	51,000	.0022	0.	....	....	
13,000	52,000	.0022	0.	....	....	
13,250	53,000	.0022	0.	....	....	
13,500	54,000	.0025	.0003	....	....	
13,750	55,000	.0025	0.	....	....	
14,000	56,000	.0025	0.	....	....	
14,250	57,000	.0025	0.	....	....	
14,500	58,000	.0025	0.	....	....	
14,750	59,000	.0027	.0002	....	....	
15,000	60,000	.0027	0.	....	....	
250	1,000	....	....	.0005—	.0005—	
15,250	61,000	.0027	0.	....	....	Elastic limit.
15,500	62,000	.0035	.0008	....	....	
15,750	63,000	.0045	.0010	....	....	
16,000	64,000	.0055	.0010	....	....	
16,250	65,000	.0060	.0005	....	....	
16,500	66,000	.0070	.0010	....	....	
16,750	67,000	.0080	.0010	....	....	
17,000	68,000	.0090	.0010	....	....	
17,250	69,000	.0097	.0007	....	....	
17,500	70,000	.0100	.0003	....	....	
250	1,000	....	....	.0070	.0065	
17,750	71,000	.0110	.0010	....	....	
18,000	72,000	.0125	.0015	....	....	
18,250	73,000	.0135	.0010	....	....	
18,500	74,000	.0145	.0010	....	....	
18,750	75,000	.0155	.0010	....	....	
19,000	76,000	.0165	.0010	....	....	
19,250	77,000	.0175	.0010	....	....	
19,500	78,000	.0185	.0010	....	....	
19,750	79,000	.0195	.0010	....	....	
20,000	80,000	.0210	.0015	....	....	
250	1,000	....	....	.0165	.0095	
20,500	82,000	.0230	.0020	....	....	
21,000	84,000	.0260	.0030	....	....	
21,500	86,000	.0285	.0025	....	....	
22,000	88,000	.0315	.0030	....	....	
22,500	90,000	.0350	.0035	....	....	
23,000	92,000	.0395	.0045	....	....	
23,500	94,000	.0435	.0040	....	....	
24,000	96,000	.0475	.0040	....	....	
24,500	98,000	.0535	.0060	....	....	
25,000	100,000	.0590	.0055	....	....	
25,500	102,000	.0690	.0100	....	....	
26,000	104,000	.0840	.0150	....	....	
0	0	.0900	.0060	....	....	Ultimate strength. Elongation at fracture.

General summary.

Tensile strength per square inch of original section	pounds..	104,000
Elastic limit per square inch of original section	do ...	61,000
Elongation per inch after rupture	inch..	0.0900
Elongation per inch under strain at elastic limit	do....	.0027
Reduction in diameter at point of rupture	do....	.034
Reduction in area after rupture, per centum of original section		11.6
Position of rupture		".35 from curve of neck.
Character of broken surface		granular, 85 per cent.; dull smoky spot, 15 per cent.

No. 295.

Compression test.

Marks on specimen J¹C
Length, 5″.00.
Diameter, ″.798.
Sectional area .50 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.				
1,000	2,000	.00005	.00005			
1,500	3,000	.00010	.00005			
2,000	4,000	.00015	.00005			
2,500	5,000	.00020	.00005			
500	1,000			.0		
3,000	6,000	.00025	.00005			
3,500	7,000	.00030	.00005			
4,000	8,000	.00035	.00005			
4,500	9,000	.00045	.00010			
5,000	10,000	.00055	.00010			
500	1,000			—.00005	—.00005	
5,500	11,000	.00060	.00005			
6,000	12,000	.00065	.00005			
6,500	13,000	.00075	.00010			
7,000	14,000	.00085	.00010			
7,500	15,000	.00095	.00010			
500	1,000			—.00005	.0	
8,000	16,000	.00100	.00005			
8,500	17,000	.00105	.00005			
9,000	18,000	.00110	.00005			
9,500	19,000	.00120	.00010			
10,000	20,000	.00130	.00010			
500	1,000			—.00005	0.	
10,500	21,000	.00145	.00015			
11,000	22,000	.00150	.00005			
11,500	23,000	.00155	.00005			
12,000	24,000	.00160	.00005			
12,500	25,000	.00170	.00010			
500	1,000			—.00005	0.	
13,000	26,000	.00180	.00010			
13,500	27,000	.00195	.00015			
14,000	28,000	.00200	.00005			
14,500	29,000	.00205	.00005			
15,000	30,000	.00215	.00010			
500	1,000			—.00005		
15,500	31,000	.00225	.00010			
16,000	32,000	.00240	.00015			
16,500	33,000	.00250	.00010			
17,000	34,000	.00255	.00005			
17,500	35,000	.00265	.00010			
500	1,000			.00005	0.	
18,000	36,000	.00270	.00005			
18,500	37,000	.00285	.00015			
19,000	38,000	.00295	.00010			
19,500	39,000	.00305	.00010			
20,000	40,000	.00310	.00005			
500	1,000			—.00005	0.	
20,500	41,000	.00315	.00005			
21,000	42,000	.00335	.00020			
21,500	43,000	.00345	.00010			
22,000	44,000	.00355	.00010			
22,500	45,000	.00360	.00005			
500	1,000			—.00005	0.	
23,000	46,000	.00365	.00005			
23,500	47,000	.00375	.00010			
24,000	48,000	.00390	.00015			
24,500	49,000	.00400	.00010			
25,000	50,000	.00405	.00005			
500	1,000			—.00005	0.	
25,500	51,000	.00415	.00010			
26,000	52,000	.00425	.00010			
26,500	53,000	.00435	.00010			
27,000	54,000	.00445	.00010			
27,500	55,000	.00460	.00015			
500	1,000			.00060	.00065	

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28,000	56,000	.00490	.00030	....	....	
28,500	57,000	.00505	.00015	....	....	
29,000	58,000	.00515	.00010	....	....	Elastic limit.
29,500	59,000	.00600	.00085	....	....	
30,000	60,000	.00700	.00100	....	....	
500	1,000	....	....	.00150	.00150	
30,500	61,000	.00775	.00075	....	....	
31,000	62,000	.00900	.00125	....	....	
31,500	63,000	.00995	.00095	....	....	
32,000	64,000	.01150	.00160	....	....	
32,500	65,000	.01285	.00135	....	....	
500	1,000	....	....	.00670	.00520	
33,000	66,000	.01405	.00120	....	....	
33,500	67,000	.01550	.00145	....	....	
34,000	68,000	.01675	.00125	....	....	
34,500	69,000	.01875	.00200	....	....	
35,000	70,000	.02050	.00175	....	....	
500	1,000	....	....	.01880	.00710	
35,500	71,000	.02200	.00150	....	....	
36,000	72,000	.02310	.00110	....	....	Deflection at middle, ″.03.
36,500	73,000	.02500	.00190	....	....	
500	1,000	....	....	.01820	.00440	Micrometer removed.
40,000	80,000	....	....	....	....	
0.	0.	....	....	.03400	.01580	
45,000	90,000	....	....	....	....	
0.	0.	....	....	.06500	.03100	
47,100	94,200	....	....	....	....	Ultimate strength.

Failed by triple flexures; the convex side of middle bend towards center of ring from whence it was taken.

General summary.

Elastic limit per square inch .... pounds.. 58,000
Compression per inch under strain at elastic limit.................................. inch... 0.00515

No. 296.

Compression test.

Marks on specimen, J.,C.
Length, 5″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	....	....	
1,000	2,000	.00010	.00010	....	....	
1,500	3,000	.00020	.00010	....	....	
2,000	4,000	.00030	.00010	....	....	
2,500	5,000	.00045	.00015	....	....	
500	1,000	....	....	0.	....	
3,000	6,000	.00055	.00010	....	....	
3,500	7,000	.00065	.00010	....	....	
4,000	8,000	.00075	.00010	....	....	
4,500	9,000	.00085	.00010	....	....	
5,000	10,000	.00095	.00010	....	....	
500	1,000	....	....	0.	....	
5,500	11,000	.00100	.00005	....	....	
6,000	12,000	.00105	.00005	....	....	

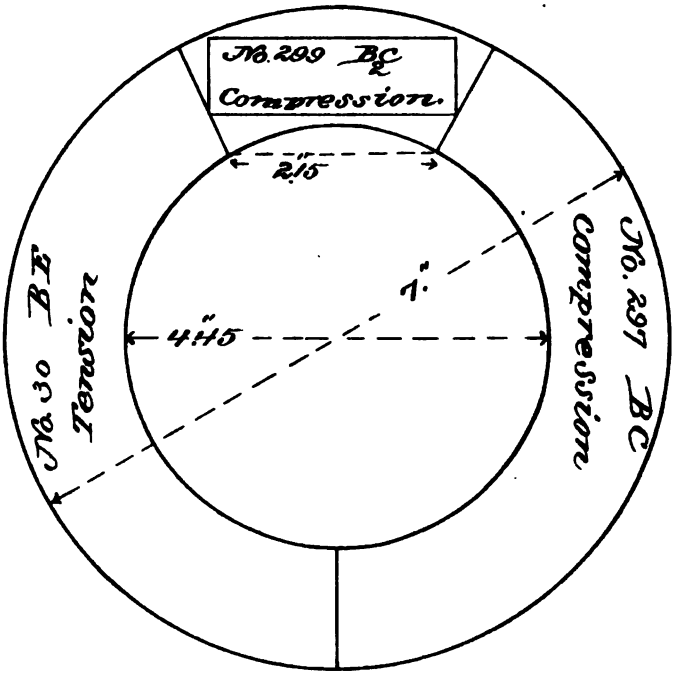
Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
6,500	13,000	.00110	.00005			
7,000	14,000	.00120	.00010			
7,500	15,000	.00135	.00015			
500	1,000			0.		
8,000	16,000	.00145	.00010			
8,500	17,000	.00155	.00010			
9,000	18,000	.00165	.00010			
9,500	19,000	.00175	.00010			
10,000	20,000	.00190	.00015			
500	1,000			0.		
10,500	21,000	.00195	.00005			
11,000	22,000	.00200	.00005			
11,500	23,000	.00210	.00010			
12,000	24,000	.00220	.09010			
12,500	25,000	.00230	.00010			
500	1,000			.00005	.00005	
13,000	26,000	.00245	.00015			
13,500	27,000	.00255	.00010			
14,000	28,000	.00265	.00010			
14,500	29,000	.00275	.00010			
15,000	30,000	.00285	.00010			
500	1,000			.00010	.00005	
15,500	31,000	.00285	0.			
16,000	32,000	.00300	.00015			
16,500	33,000	.00305	.00005			
17,000	34,000	.00315	.00010			
17,500	35,000	.00325	.00010			
500	1,000			.00015	.00005	
18,000	36,000	.00330	.00005			
18,500	37,000	.00345				
19,000	38,000	.00355				
19,500	39,000	.00365				
20,000	40,000	.00375	.00010			
500	1,000			.00020	.00005	
20,500	41,000	.00380	.00005			
21,000	42,000	.00385	.00005			
21,500	43,000	.00395	.00010			
22,000	44,000	.00405	.00010			
22,500	45,000	.09415	.00010			
500	1,000			.00025	.00005	
23,000	46,000	.00425	.00010			
23,500	47,000	.00440	.00015			
24,000	48,000	.00450	.00010			
24,500	49,000	.00460	.00010			Elastic limit.
25,000	50,000	.00480	.00020			
500	1,000			.00040	.00015	
25,500	51,000	.00505	.00025			
26,000	52,000	.00515	.00910			
26,500	53,000	.00550	.00035			
27,000	54,000	.00615	.00065			
27,500	55,000	.00710	.00095			
500	1,000			.00190	.00150	
28,000	56,000	.00785	.00075			
28,500	57,000	.00900	.00115			
29,000	58,000	.01040	.00140			
29,500	59,000	.01150	.00110			
30,000	60,000	.01300	.00150			
500	1,000			.00715	.06525	
30,500	61,000	.01400	.00100			
31,000	62,000	.01510	.00110			
31,500	63,000	.01685	.00175			
32,000	64,000	.01810	.00125			
32,500	65,000	.01945	.00135			
500	1,000			.01350	.00635	Micrometer removed.
35,000	70,000					
0	0			.02450	.01100	
40,000	80,000					
0	0			.09000	.06550	
45,000	90,000					Ultimate strength.

Failed by triple flexure; the convex side of middle bend towards centre of ring from whence it was taken.

General summary.

Elastic limit, per square inch	pounds..	49,000
Compression per inch under strain at elastic limit	inch..	0.00460

Band, 3.2 inch Gun.



S Ex 35 49 1

MANNER OF PREPARING SPECIMENS.

A ring 1 inch thick was cut from one end of the band.

From this ring three pieces were obtained, located as shown on the following diagram.

Specimen $^{\mathrm{B}}{}_{2}{}^{\mathrm{C}}$ was turned from a segment 2.15 inches long (measured on the chord of the inner circle), which was removed by radial cuts.

The remaining portion of the ring was cut into two pieces, from which were taken B C and B E.

No. 30.

Tension test.

Marks on specimen, B E.
Length, 2″.
Diameter, ″.564.
Sectional area, .25 square inch.

This portion of the ring was straightened while hot, and specimen taken from central portion.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.				
1,250	5,000	.0002	.0002			
250	1,000			.0002	.0002	
2,500	10,000	.0005	.0003			
250	1,000			.0002	0.	
3,750	15,000	.0005	0.			
250	1,000			.0002	0.	
5,000	20,000	.0010	.0005			
250	1,000			.0002	0.	
6,250	25,000	.0010	0.			
250	1,000			.0002	0.	
7,500	30,000	.0012	.0002			
250	1,000			.0002	0.	
8,750	35,000	.0015	.0003			
250	1,000			.0002	0.	
10,000	40,000	.0015	0.			
250	1,000			.0002	0.	
10,250	41,000	.0017	.0002			
10,500	42,000	.0020	.0003			
10,750	43,000	.0020	.0			
11,000	44,000	.0020	.0			
11,250	45,000	.0022	.0002			
250	1,000			.0002	0.	
11,500	46,000	.0022	0.			
11,750	47,000	.0022	0.			
12,000	48,000	.0022	0.			
12,250	49,000	.0025	.0003			
12,500	50,000	.0025	0.			
250	1,000			.0005	.0003	
12,750	51,000	.0025	0.			
13,000	52,000	.0025	0.			
13,250	53,000	.0025	0.			
13,500	54,000	.0025	0.			
13,750	55,000	.0027	.0002			
250	1,000			.0005	0.	
14,000	56,000	.0030	.0003			
14,250	57,000	.0030	0.			
14,500	58,000	.0030	0.			
14,750	59,000	.0030	0.			
15,000	60,000	.0032	.0002			
250	1,000			.0010	.0005	
15,250	61,000	.0032	0.			
15,500	62,000	.0032	0.			
15,750	63,000	.0035	.0003			
16,000	64,000	.0035	0.			

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16, 250	65, 000	.0037	.0002	....	....	
250	1, 000	....	....	.0010	0.	
16, 500	66, 000	.0037	0.	....	....	
16, 750	67, 000	.0040	.0003	....	....	
17, 000	68, 000	.0040	0.	....	....	
17, 250	69, 000	.0040	0.	....	....	
17, 500	70, 000	.0040	0.	....	....	
250	1, 000	....	....	.0010	0.	
17, 750	71, 000	.0040	0.	....	....	
18, 000	72, 000	.0040	0.	....	....	
18, 250	73, 000	.0040	0.	....	....	Elastic limit.
18, 500	74, 000	.0205	.0165	....	....	
18, 750	75, 000	.0225	.0020	....	....	
250	1, 000	....	....	.0185	.0175	
19, 000	76, 000	.0235	.0010	....	....	
19, 250	77, 000	.0245	.0010	....	....	
19, 500	78, 000	.0260	.0015	....	....	
19, 750	79, 000	.0267	.0007	....	....	
20, 000	80, 000	.0285	.0018	....	....	
250	1, 000	....	....	.0240	.0055	
20, 500	82, 000	.0310	.0025	....	....	
21, 000	84, 000	.0340	.0030	....	....	
21, 500	86, 000	.0375	.0035	....	....	
22, 000	88, 000	.0405	.0030	....	....	
22, 500	90, 000	.0440	.0035	....	....	
23, 000	92, 000	.0485	.0045	....	....	
23, 500	94, 000	.0540	.0055	....	....	
24, 000	96, 000	.0590	.0050	....	....	
24, 500	98, 000	.0655	.0065	....	....	
25, 000	100, 000	.0745	.0090	....	....	
25, 500	102, 000	.0850	.0115	....	....	
26, 000	104, 000	.0985	.0135	....	....	
26, 500	106, 000	.1235	.0250	....	....	
26, 980	107, 920	....	....	....	....	Ultimate strength.
23, 900	95, 600	....	....	....	....	Load at time of fracture.
0	0	.2500	....	....	....	Elongation after fracture.

General summary.

Tensile strength per square inch of original section	pounds..	107, 920
Elastic limit per square inch of original section	do....	73, 000
Elongation per inch after rupture	....inch..	0.2500
Elongation per inch under strain at elastic limit	do...	.0040
Reduction in diameter at point of rupture	do ..	.134
Reduction in area after rupture, per centum of original section		42.0

Position of rupture ″.4 from middle of the stem.
Character of broken surface, fine silky. Fractured ends cup shaped.

No. 297.

Compression test.

Marks on specimen B C
Length, 5″.
Diameter, ″.798.
Sectional area, .50 square inch.

This portion of the ring was straightened cold. It was struck with a maul, placed under a screw press, and finally straightened in one of the holder jaws of the testing machine; employing a pressure of 200,000 pounds.

The ends were then squared and centered, and from it was turned this specimen:

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0	....	....	....	
1,000	2,000	.00000	....	....	....	
1,500	3,000	.00005	.00005	....	....	
2,000	4,000	.00015	.00010	....	....	
2,500	5,000	.00025	.00010	....	....	
500	1,000	....	....	0	....	
3,000	6,000	.00035	.00010	....	....	
3,500	7,000	.00045	.00010	....	....	
4,000	8,000	.00050	.00005	....	....	
4,500	9,000	.00055	.00005	....	....	
5,000	10,000	.00060	.00005	....	....	
500	1,000	....	....	0	....	
5,500	11,000	.00065	.00005	....	....	
6,000	12,000	.00070	.00005	....	....	
6,500	13,000	.00080	.00010	....	....	
7,000	14,000	.00085	.00005	....	....	
7,500	15,000	.00100	.00015	....	....	
500	1,000	....	....	0	....	
8,000	16,000	.00105	.00005	....	....	
8,500	17,000	.00115	.00010	....	....	
9,000	18,000	.00125	.00010	....	....	
9,500	19,000	.00135	.00010	....	....	
10,000	20,000	.00145	.00010	....	....	
500	1,000	....	....	.00010	....	
10,500	21,000	.00165	.00020	....	....	
11,000	22,000	.00170	.00005	....	....	
11,500	23,000	.00185	.00015	....	....	
12,000	24,000	.00200	.00015	....	....	
12,500	25,000	.00205	.00005	....	....	
500	1,000	....	....	.00015	.00005	
13,000	26,000	.00220	.00015	....	....	
13,500	27,000	.00235	.00015	....	....	
14,000	28,000	.00240	.00005	....	....	
14,500	29,000	.00250	.00010	....	....	
15,000	30,000	.00260	.00010	....	....	
500	1,000	....	....	.00025	.00010	
15,500	31,000	.00280	.00020	....	....	
16,000	32,000	.00295	.00015	....	....	
16,500	33,000	.00300	.00005	....	....	
17,000	34,000	.00310	.00010	....	....	
17,500	35,000	.00330	.00020	....	....	
500	1,000	....	....	.00035	.00010	
18,000	36,000	.00340	.00010	....	....	
18,500	37,000	.00350	.00010	....	....	
19,000	38,000	.00365	.00015	....	....	
19,500	39,000	.00380	.00015	....	....	
20,000	40,000	.00400	.00020	....	....	
500	1,000	....	....	.00040	.00005	
20,500	41,000	.00420	.00020	....	....	
21,000	42,000	.00430	.00010	....	....	
21,500	43,000	.00445	.00015	....	....	
22,000	44,000	.00455	.00010	....	....	
22,500	45,000	.00470	.00015	....	....	
500	1,000	....	....	.00045	.00005	
23,000	46,000	.00495	.00025	....	....	

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
23,500	47,000	.00505	.00010	....	....	
24,000	48,000	.00515	.00010	....	....	
24,500	49,000	.00540	.00025	....	....	
25,000	50,000	.00550	.00010	....	....	
500	1,000	....	....	.00050	.00005	
25,500	51,000	.00585	.00035	....	....	
26,000	52,000	.00595	.00010	....	....	
26,500	53,000	.00605	.00010	....	....	
27,000	54,000	.00615	.00010	....	....	
27,500	55,000	.00635	.00020	....	....	
500	1,000	....	....	.00065	.00015	
28,000	56,000	.00660	.00025	....	....	
28,500	57,000	.00680	.00020	....	....	
29,000	58,000	.00695	.00015	....	....	
29,500	59,000	.00710	.00015	....	....	
30,000	60,000	.00730	.00020	....	....	
500	1,000	....	....	.00080	.00015	
30,500	61,000	.00755	.00025	....	....	
31,000	62,000	.00785	.00030	....	....	
31,500	63,000	.00800	.00015	....	....	
32,000	64,000	.00820	.00020	....	....	
32,500	65,000	.00835	.00015	....	....	
500	1,000	....	....	.00115	.00035	
33,000	66,000	.00865	.00030	....	....	
33,500	67,000	.00900	.00035	....	....	
34,000	68,000	.00925	.00025	....	....	
34,500	69,000	.00950	.00025	....	....	
35,000	70,000	.00980	.00030	....	....	
500	1,000	....	....	.00180	.00065	
35,500	71,000	.01015	.00035	....	....	
36,000	72,000	.01050	.00035	....	....	
36,500	73,000	.01060	.00010	....	....	
37,000	74,000	.01100	.00040	....	....	
37,500	75,000	.01130	....	....	....	
500	1,000	....	....	.00265	.00085	
50,000	100,000	....	....	....	....	
0	0	....	....	.03000	.00035	
53,300	106,600	....	....	....	....	Ultimate strength.

Failed by triple flexure; the convex side of middle bend towards the outside of ring from whence it was taken.

Deflection continued till the specimen was bent into an ᴜ shape, and closed down till the ends met. A number of small cracks developed on the tension side of the middle bend.

No. 299.

Compression test.

Marks on specimen, B_2C
Length, 2″.605.
Diameter, ″.798.
Sectional area, .50 square inch.

The ends of this portion of the ring were squared and centered, and a specimen turned so that the axis of the cylinder was at right angles with the radius of the band.

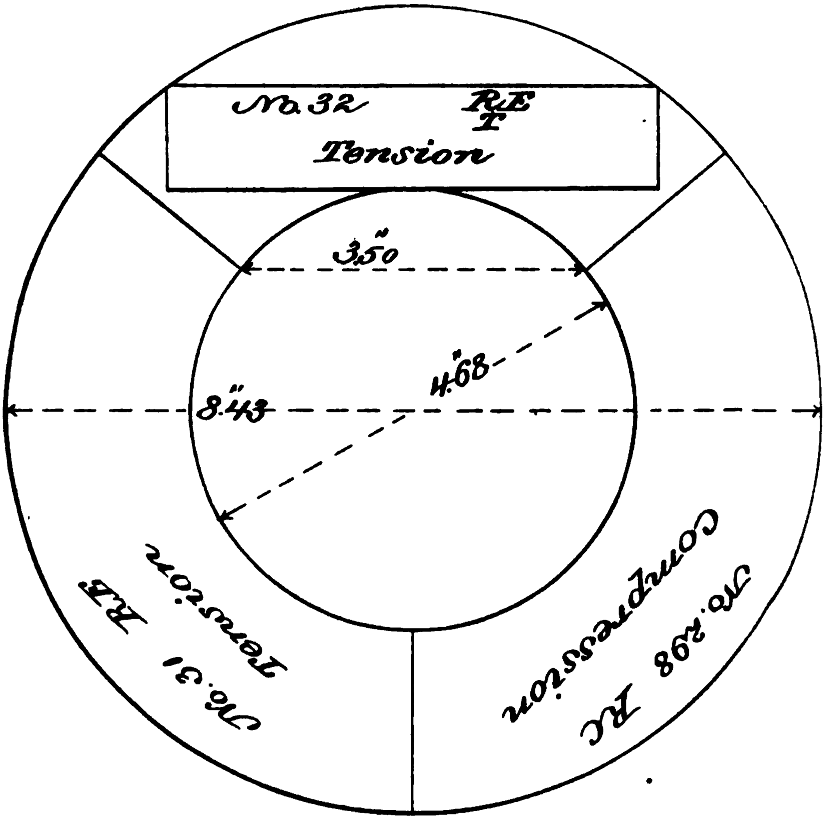
Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.				
1,000	2,000	0.				
1,500	3,000	.00005	.00005			
2,000	4,000	.00010	.00005			
2,500	5,000	.00015	.00005			
500	1,000			0.		
3,000	6,000	.00025	.00010			
3,500	7,000	.00030	.00005			
4,000	8,000	.00035	.00005			
4,500	9,000	.00040	.00005			
5,000	10,000	.00050	.00010			
500	1,000			0.		
5,500	11,000	.00055	.00005			
6,000	12,000	.00060	.00005			
6,500	13,000	.00060	0.			
7,000	14,000	.00065	.00005			
7,500	15,000	.00075	.00010			
500	1,000			0.		
8,000	16,000	.00090	.00015			
8,500	17,000	.00095	.00005			
9,000	18,000	.00100	.00005			
9,500	19,000	.00105	.00005			
10,000	20,000	.00110	.00005			
500	1,000			0.		
10,500	21,000	.00110	0.			
11,000	22,000	.00115	.00003			
11,500	23,000	.00120	.00005			
12,000	24,000	.00130	.00010			
12,500	25,000	.00135	.00005			
500	1,000			0.		
13,000	26,000	.00150	.00015			
13,500	27,000	.00155	.00005			
14,000	28,000	.00160	.00005			
14,500	29,000	.00160	0.			
15,000	30,000	.00165	.00005			
500	1,000			0.		
15,500	31,000	.00175	.00010			
16,000	32,000	.00180	.00005			
16,500	33,000	.00185	.00005			
17,000	34,000	.00190	.00005			
17,500	35,000	.00195	.00005			
500	1,000			—.00005	—.00005	
18,000	36,000	.00200	.00005			
18,500	37,000	.00200	0.			
19,000	38,000	.00210	.00010			
19,500	39,000	.00215	.00005			
20,000	40,000	.00230	.00015			
500	1,000			—.00010	—.00005	
20,500	41,000	.00225	.00005			
21,000	42,000	.00230	.00005			
21,500	43,000	.00240	.00010			
22,000	44,000	.00245	.00005			
22,500	45,000	.00250	.00005			
500	1,000			—.00015	—.00005	
23,000	46,000	.00255	.00005			
23,500	47,000	.00255	0.			
24,000	48,000	.00265	.00010			
24,500	49,000	.00270	.00005			
25,000	50,000	.00280	.00010			
500	1,000			—.00015	0.	

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
25, 500	51, 000	.00285	.00005	....	....	
26, 000	52, 000	.00295	.00010	....	....	
26, 500	53, 000	.00295	0.	....	....	
27, 000	54, 000	.00300	.00005	....	....	
27, 500	55, 000	.00315	.00005	....	....	
500	1, 000	....	....	—.00015	0.	
28, 000	56, 000	.00310	.00005	....	....	
28, 500	57, 000	.00310	0.	....	....	
29, 000	58, 000	.00315	.00005	....	....	
29, 500	59, 000	.00325	.00010	....	....	
30, 000	60, 000	.00330	.00005	....	....	
500	1, 000	....	....	—.00010	.00005	
30, 500	61, 000	.00345	.00015	....	....	
31, 000	62, 000	.00350	.00005	....	....	
31, 500	63, 000	.00355	.00005	....	....	
32, 000	64, 000	.00365	.00010	....	....	
32, 500	65, 000	.00370	.00005	....	....	
500	1, 000	....	....	—.00010	0.	
33, 000	66, 000	.00375	.00005	....	....	
33, 500	67, 000	.00380	.00005	....	....	
34, 000	68, 000	.00385	.00005	....	....	
34, 500	69, 000	.00395	.00010	....	....	
35, 000	70, 000	.00400	.00005	....	....	
500	1, 000	....	....	—.00005	.00005	
35, 500	71, 000	.00405	.00005	....	....	
36, 000	72, 000	.00410	.00005	....	....	
36, 500	73, 000	.00415	.00005	....	....	
37, 000	74, 000	.00425	.00010	....	....	
37, 500	75, 000	.00430	.00005	....	....	
500	1, 000	....	....	0.	.00005	
38, 000	76, 000	.00445	.00015	....	....	
38, 500	77, 000	.00455	.00010	....	....	
39, 000	78, 000	.00460	.00005	....	....	Elastic limit.
39, 500	79, 000	.00470	.00010	....	....	
40, 000	80, 000	.00485	.00015	....	....	
500	1, 000	....	....	.00040	.00040	
40, 500	81, 000	.00505	.00020	....	....	
41, 000	82, 000	.00520	.00015	....	....	
41, 500	83, 000	.00545	.00025	....	....	
42, 000	84, 000	.00570	.00025	....	....	
42, 500	85, 000	.00615	.00045	....	....	
500	1, 000	....	....	.00130	.00090	Micrometer removed.
55, 000	110, 000	....	....	....	....	
0	0	....	....	.02000	.01870	
62, 500	125, 000	....	....	....	....	
0	0	....	....	.03600	.01600	
75, 000	150, 000	....	....	....	....	
0	0	....	....	.09000	.05400	
76, 000	152, 000	....	....	....	....	Ultimate strength.

General summary.

Elastic limit per square inch	pounds..	78, 000
Compression per inch under strain at elastic limit	inch..	0.00460

Trunnion ring, 3.2 inch Gun.



MANNER OF PREPARING SPECIMENS.

A ring 1$\frac{1}{16}$ inches thick was cut from the forward end of the trunnion ring.

From the ring three pieces were obtained, as shown on the following diagram.

Specimen $^{a}_{T}$ was turned from a segment 3½ inches long (measured on the chord of the inner circle), which was removed by radial cuts.

The remaining portion of the ring was cut into two pieces, from which were taken R E and R C

No. 31.

Tension test.

Marks on specimen R E
Length, 2''.00.
Diameter, ''.564.
Sectional area, .25 square inches.

This portion of the ring was straightened while hot, from which this specimen was turned.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	
1,250	5,000	0.	....	....	....	
250	1,000	....	....	.0	....	
2,500	10,000	.0002	.0002	....	....	
250	1,000	....	....	.0	....	
3,750	15,000	.0005	.0003	....	....	
250	1,000	....	....	.0	....	
5,000	20,000	.0007	.0002	....	....	
250	1,000	....	....	.0	....	
6,250	25,000	.0010	.0003	....	....	
250	1,000	....	....	.0	....	
7,500	30,000	.0012	.0002	....	....	
250	1,000	....	....	.0	....	
8,750	35,000	.0015	.0003	....	....	
250	1,000	....	....	.0	....	
10,000	40,000	.0015	.0	....	....	
250	1,000	....	....	.0	....	
10,250	41,000	.0015	.0	....	....	
10,500	42,000	.0017	.0002	....	....	
10,750	43,000	.0017	.0	....	....	
11,000	44,000	.0017	.0	....	....	
11,250	45,000	.0020	.0003	....	....	
250	1,000	....	....	.0	....	
11,500	46,000	.0020	.0	....	....	
11,750	47,000	.0020	.0	....	....	
12,000	48,000	.0020	.0	....	....	
12,250	49,000	.0020	.0	....	....	
12,500	50,000	.0020	.0	....	....	
250	1,000	....	....	.0	....	
12,750	51,000	.0022	.0002	....	....	
13,000	52,000	.0022	.0	....	....	
13,250	53,000	.0022	.0	....	....	
13,500	54,000	.0022	.0	....	....	
13,750	55,000	.0025	.0003	....	....	
250	1,000	....	....	.0	....	
14,000	56,000	.0025	.0	....	....	
14,250	57,000	.0025	.0	....	....	
14,500	58,000	.0025	.0	....	....	
14,750	59,000	.0027	.0002	....	....	Elastic limit.
15,000	60,000	.0155	.0128	....	....	
250	1,000	....	....	.0130	.0130	
15,250	61,000	.0170	.0015	....	....	
15,500	62,000	.0180	.0010	....	....	
15,750	63,000	.0190	.0010	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16, 000	64, 000	.0200	.0010	....	....	
16, 250	65, 000	.0215	.0015	....	....	
250	1, 000	....	....	.0180	.0050	
16, 500	66, 000	.0225	.0010	....	....	
16, 750	67, 000	.0240	.0015	....	....	
17, 000	68, 000	.0255	.0015	....	....	
17, 250	69, 000	.0265	.0010	....	....	
17, 500	70, 000	.0280	.0015	....	....	
250	1, 000	....	....	.0205	.0025	
18, 000	72, 000	.0320	.0040	....	....	
18, 500	74, 000	.0355	.0035	....	....	
19, 000	76, 000	.0400	.0045	....	....	
19, 500	78, 000	.0440	.0040	....	....	
20, 000	80, 000	.0495	.0055	....	....	
250	1, 000	....	....	.0450	.0245	
20, 500	82, 000	.0550	.0055	....	....	
21, 000	84, 000	.0640	.0090	....	....	
21, 500	86, 000	.0720	.0080	....	....	
22, 000	88, 000	.0835	.0115	....	....	
22, 500	90, 000	.0985	.0150	....	....	
23, 000	92, 000	.1240	.0255	....	....	
23, 500	94, 000	.1830	.0590	....	....	Ultimate strength.
0	0	.2100	....	....	....	Elongation after fracture.

General summary.

Tensile strength per square inch of original section	pounds..	94, 000
Elastic limit per square inch of original section	do ...	59, 000
Elongation per inch after rupture	inch..	0. 2100
Elongation per inch under strain at elastic limit	do....	.0027
Reduction in diameter at point of rupture	do ...	.104
Reduction in area after rupture, per centum of original section		33. 6
Position of rupture		".50 from curve of neck.
Character of broken surface		Silky; surface irregular, vesicular.

No. 32.

Tension test.

Marks on specimen, ${}^{\mathrm{R\,E}}_{\mathrm{T}}$.
Length, 2".00.
Diameter, ".564.
Sectional area, .25 square inches.

From this portion of the ring was milled a prism $1\frac{1}{8}''$ square by $5\frac{1}{4}''$ long, from which was turned this specimen.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	....	....	
1, 250	5, 000	0.	....	....	....	
250	1, 000	....	....	0.	....	
2, 500	10, 000	.0002	.0002	....	....	
250	1, 000	....	....	0.	....	
3, 750	15, 000	.0005	.0003	....	....	
250	1, 000	....	....	0.	....	
5, 000	20, 000	.0005	0.	....	....	
250	1, 000	....	....	0.	....	
6, 250	25, 000	.0010	.0005	....	....	
250	1, 000	....	....	0.	....	
7, 500	30, 000	.0010	0.	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	....	....	0.	....	
8, 750	35, 000	.0015	.0005	....	....	
250	1, 000	....	....	0.	....	
10, 000	40, 000	.0015	0.	....	....	
250	1, 000	....	....	0.	....	
10, 250	41, 000	.0017	.0002	....	....	
10, 500	42, 000	.0017	0.	....	....	
10, 750	43, 000	.0020	.0003	....	....	
11, 000	44, 000	.0020	0.	....	....	
11, 250	45, 000	.0020	0.	....	....	
250	1, 000	....	....	0.	....	
11, 500	46, 000	.0020	0.	....	....	
11, 750	47, 000	.0020	0.	....	....	
12, 000	48, 000	.0022	.0002	....	....	
12, 250	49, 000	.0022	0.	....	....	
12, 500	50, 000	.0025	.0003	....	....	
250	1, 000	....	....	0.	....	
12, 750	51, 000	.0025	0.	....	....	
13, 000	52, 000	.0025	0.	....	....	
13, 250	53, 000	.0025	0.	....	....	
13, 500	54, 000	.0025	0.	....	....	
13, 750	55, 000	.0027	.0002	....	....	
250	1, 000	....	....	0.	....	
14, 000	56, 000	.0027	0.	....	....	
14, 250	57, 000	.0030	.0003	....	....	Elastic limit.
14, 500	58, 000	.0040	.0010	....	....	
14, 750	59, 000	.0050	.0010	....	....	
15, 000	60, 000	.0060	.0010	....	....	
250	1, 000	....	....	.0035	.0035	
15, 250	61, 000	.0065	.0005	....	....	
15, 500	62, 000	.0075	.0010	....	....	
15, 750	63, 000	.0085	.0010	....	....	
16, 000	64, 000	.0095	.0010	....	....	
16, 250	65, 000	.0100	.0005	....	....	
250	1, 000	....	....	.0075	.0040	
16, 500	66, 000	.0110	.0010	....	....	
16, 750	67, 000	.0120	.0010	....	....	
17, 000	68, 000	.0130	.0010	....	....	
17, 250	69, 000	.0140	.0010	....	....	
17, 500	70, 000	.0155	.0015	....	....	
250	1, 000	....	....	.0120	.0045	
18, 000	72, 000	.0180	.0025	....	....	
18, 500	74, 000	.0205	.0025	....	....	
19, 000	76, 000	.0230	.0025	....	....	
19, 500	78, 000	.0250	.0020	....	....	
20, 000	80, 000	.0290	.0040	....	....	
250	1, 000	....	....	.0240	.0120	
20, 500	82, 000	.0310	.0020	....	....	
21, 000	84, 000	.0350	.0040	....	....	
21, 500	86, 000	.0390	.0040	....	....	
22, 000	88, 000	.0430	.0040	....	....	
22, 500	90, 000	.0480	.0050	....	....	
23, 000	92, 000	.0530	.0050	....	....	
23, 500	94, 000	.0610	.0080	....	....	
24, 000	96, 000	.0695	.0085	....	....	
24, 500	98, 000	.0825	.0130	....	....	
25, 000	100, 000	.1100	.0275	....	....	
25, 260	101, 040	....	....	....	....	Ultimate strength.
0.	0.	.2000	....	....	....	Elongation after fracture.

General summary.

Tensile strength per square inch of original section........................pounds.. 101, 040
Elastic limit per square inch of original section........................do.... 57, 000
Elongation per inch after rupture........................inch.. 0. 2000
Elongation per inch under strain at elastic limit........................do.... .0030
Reduction in diameter at point of rupture........................do.... .084
Reduction in area after rupture, per centum of original section........................ 27. 6
Position of rupture........................".6 from curve of neck.
Character of broken surface............Granular, radiating from a dull spot at circumference of stem. Surface cracks developed in the vicinity of fracture.

No. 298.

Compression test.

Marks on specimen R C
Length, 5".00.
Diameter, ".798.
Sectional area, .50 square inch.

This portion of the ring was straightened while hot; from which this specimen was turned.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.				
1,000	2,000	.00005	.00005			
1,500	3,000	.00005	0.			
2,000	4,000	.00010	.00005			
2,500	5,000	.00015	.00005			
500	1,000			0.		
3,000	6,000	.00025	.00010			
3,500	7,000	.00035	.00010			
4,000	8,000	.00045	.00010			
4,500	9,000	.00050	.00005			
5,000	10,000	.00060	.00010			
500	1,000			.00015	.00015	
5,500	11,000	.00070	.00010			
6,000	12,000	.00080	.00010			
6,500	13,000	.00085	.00005			
7,000	14,000	.00095	.00010			
7,500	15,000	.00100	.00005			
500	1,000			.00020	.00005	
8,000	16,000	.00115	.00015			
8,500	17,000	.00125	.00010			
9,000	18,000	.00135	.00010			
9,500	19,000	.00145	.00010			
10,000	20,000	.00150	.00005			
500	1,000			.00020	0.	
10,500	21,000	.00165	.00015			
11,000	22,000	.00170	.00005			
11,500	23,000	.00180	.00010			
12,000	24,000	.00190	.00010			
12,500	25,000	.00195	.00005			
500	1,000			.00020	0.	
13,000	26,000	.00200	.00005			
13,500	27,000	.00210	.00010			
14,000	28,000	.00220	.00010			
14,500	29,000	.00230	.00010			
15,000	30,000	.00240	.00010			
500	1,000			.00025	.00005	
15,500	31,000	.00250	.00010			
16,000	32,000	.00260	.00010			
16,500	33,000	.00265	.00005			
17,000	34,000	.00275	.00010			
17,500	35,000	.00290	.00015			
500	1,000			.00025	0.	
18,000	36,000	.00300	.00010			
18,500	37,000	.00310	.00010			
19,000	38,000	.00320	.00010			
19,500	39,000	.00330	.00010			
20,000	40,000	.00345	.00015			
500	1,000			.00025	0.	
20,500	41,000	.00350	.00005			
21,000	42,000	.00360	.00010			
21,500	43,000	.00370	.00010			
22,000	44,000	.00385	.00015			
22,500	45,000	.00400	.00015			
500	1,000			.00035	.00010	
23,000	46,000	.00420	.00020			
23,500	47,000	.00430	.00010			
24,000	48,000	.00450	.00020			
24,500	49,000	.00460	.00010			Elastic limit.
25,000	50,000	.00500	.00040			

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	....	....	.00100	.00065	
25,500	51,000	.00870	.00870	....	....	
26,000	52,000	.01050	.00180	....	....	
26,500	53,000	.01305	.00255	....	....	
27,000	54,000	.01515	.00210	....	....	
27,500	55,000	.01780	.00265	....	....	
500	1,000	....	....	.01295	.01195	
28,000	56,000	.01940	.00160	....	....	
28,500	57,000	.02155	.00215	....	....	
29,000	58,000	.02445	.00290	....	....	
29,500	59,000	.02605	.00160	....	....	
30,000	60,000	.02850	.00245	....	....	
500	1,000	....	....	.02290	.00995	Micrometer removed.
35,000	70,000	....	....	....	....	
0	0	....	....	.04350	.02060	
40,000	80,000	....	....	....	....	
0	0	....	....	.07250	.02900	
44,100	88,200	....	....	....	....	Ultimate strength.

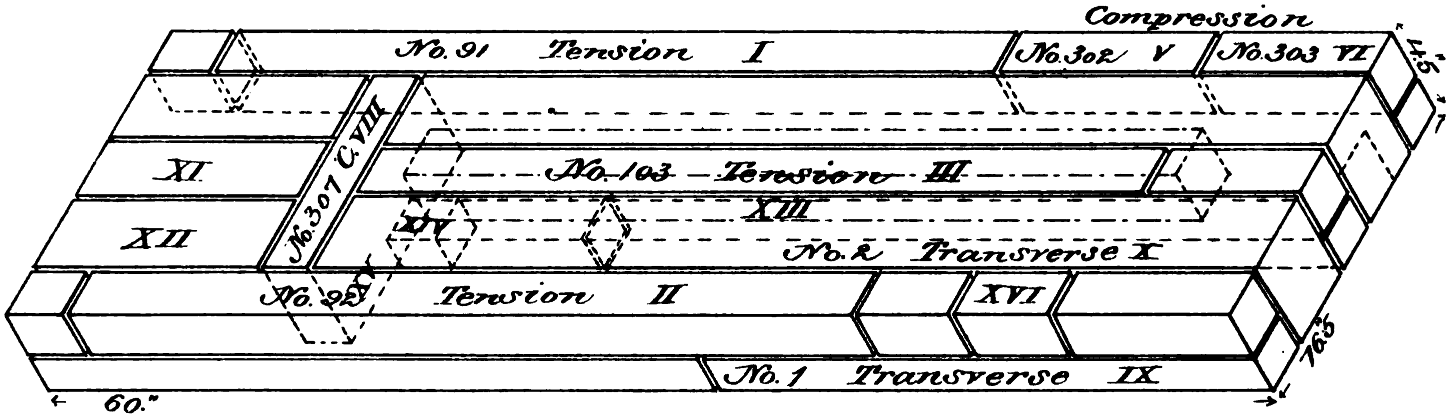
Failed by triple flexure; the convex side of middle bend towards outside of ring from whence it was taken.

Deflection continued till the specimen was bent into U-shape. When the ends came within ½" of meeting, the specimen parted into halves. The fracture was granular, radiating from a dull spot ¼"×⅛" on the tension side of the fracture.

General summary.

Elastic limit per square inch ....pounds.. 48,000
Compression per inch under strain at elastic limit ....inch.. 0.00460

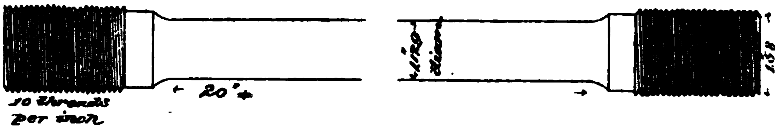
Specimens of cast (gun) iron, trial cylinder 72 inch Mortar.



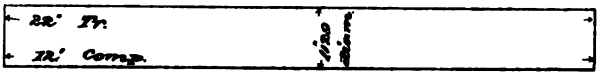
No. 310	Crushing	XIV	No 1	Tangential	XI
No. 311	do	XV	No 2	do	XII
No. 312	do	XVI	No. 3	do	XIII

Form of specimens
Cast iron.

Tension



Transverse and Compression



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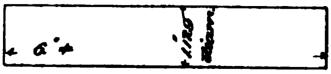
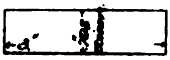
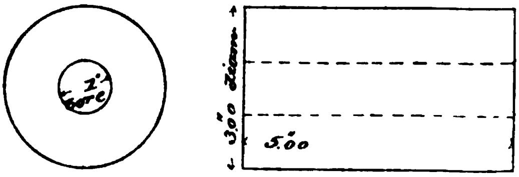


Crushing



Tangential



CAST (GUN) IRON FROM TRIAL CYLINDER.

[Cast by South Boston Iron Works, for 12″ mortar.]

No. 91.

Tension test.

Mark on bar I
Length, 30″.
Diameter, 1″.129.
Sectional area, 1.00 square inch.

Applied loads per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	....	....	Initial load.
1,000	.000013	.000013	.000010	.000010	
2,000	.000057	.000044	.000010	0.	
3,000	.000107	.000050	.000013	.000003	
4,000	.000150	.000043	.000013	0.	
5,000	.000193	.000043	.000017	.000004	
6,000	.000247	.000054	.000020	.000003	
7,000	.000297	.000050	.000027	.000007	
8,000	.000347	.000050	.000033	.000006	
9,000	.000403	.000056	.000047	.000014	
10,000	.000460	.000057	.000057	.000010	
11,000	.000520	.000060	.000063	.000006	
12,000	.000577	.000057	.000077	.000014	
13,000	.000647	.000070	.000090	.000013	
14,000	.000703	.000056	.000103	.000013	
15,000	.000787	.000084	.000120	.000017	
16,000	.000847	.000060	.000137	.000017	
17,000	.000913	.000066	.000150	.000013	
18,000	.000990	.000077	.000170	.000020	Elastic limit.
19,000	.001073	.000083	.000197	.000027	
20,000	.001160	.000087	.000230	.000033	
21,000	.001260	.000100	.000277	.000047	
22,000	.001380	.000120	.000333	.000056	
23,000	.001520	.000140	.000407	.000074	
24,000	.001687	.000167	.000510	.000103	
25,000	.001910	.000223	.000673	.000163	
26,000	.002197	.000287	.000880	.000207	
27,000	.002517	.000320	.001133	.000253	
28,000	.003020	.000503	.001560	.000427	
29,000	.003677	.000657	.002147	.000587	
29,980	....	....	....	....	Ultimate strength.

General summary.

Tensile strength per square inch of original section	pounds..	29,880
Elastic limit per square inch of original section	do....	18,000
Elongation per inch under strain at elastic limit	inch..	0.000990
Reduction in diameter at point of rupture		not perceptible
Reduction in area after rupture		not perceptible
Position of rupture		″.8 from curve of neck
Character of broken surface		coarse, granular, irregular

No. 92.

Tension test.

Marks on bar II
Length, 30″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	....	....	Initial load.
1,000	.000017	0.000017	0.000007	0.000007	
2,000	.000053	.000036	0.	− .000007	
3,000	.000090	.000037	0.	0.	
4,000	.000137	.000047	− .000010	− .000010	
5,000	.000173	.000036	− .000013	− .000003	
6,000	.000223	.000050	− .000013	0.	
7,000	.000270	.000047	− .000007	.000006	
8,000	.000317	.000047	0.	.000007	
9,000	.000383	.000066	0.	0.	
10,000	.000430	.000047	.000007	.000007	
11,000	.000487	.000057	.000013	.000006	
12,000	.000543	.000056	.000027	.000014	
13,000	.000613	.000070	.000040	.000013	
14,000	.000667	.000054	.000053	.000013	
15,000	.000740	.000073	.000067	.000014	
16,000	.000817	.000077	.000080	.000013	Elastic limit.
17,000	.000883	.000066	.000110	.000030	
18,000	.000970	.000087	.000137	.000027	
19,000	.001053	.000083	.000167	.000030	
20,000	.001150	.000097	.000213	.000046	
21,000	.001240	.000090	.000247	.000034	
22,000	.001363	.000123	.000293	.000046	
23,000	.001543	.000180	.000413	.000120	
24,000	.001707	.000164	.000517	000104	
25,000	.001933	.000226	.000683	000166	
26,000	.002207	.000274	.000893	000210	
27,000	.002563	.000356	.001167	000274	
28,000	.003063	.000500	.001593	.000426	
29,000	.003813	.000750	.002247	000654	
30,000	.004837	.001024	.003190	000943	
30,300	....	....	....	....	Ultimate strength.

General summary.

Tensile strength per square inch of original section	pounds..	30,300
Elastic limit per square inch of original section	do ...	16,000
Elongation per inch under strain at elastic limit	inch..	0.000817
Reduction in diameter at point of rupture		not perceptible.
Reduction in area after rupture		not perceptible.
Position of rupture		3½ inches from middle of bar.
Character of broken surface ., ...		coarse, granular, irregular.

No. 103.

Tension test.

Marks on bar III
Length, 30″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	....	....	Initial load.
1,000	.000007	.000007	0.	....	
2,000	.000046	.000039	0.	....	
3,000	.000097	.000051	0.	....	
4,000	.000133	.000036	0.	....	
5,000	.000170	.000037	0.	....	
6,000	.000217	.000047	0.	....	
7,000	.000267	.000050	0.	....	
8,000	.000317	.000050	0.	....	
9,000	.000366	.000049	0.	....	
10,000	.000410	.000044	.000007	.000007	
11,000	.000460	.000050	.000020	.000013	
12,000	.000527	.000067	.000027	.000007	
13,000	.000593	.000066	.000037	.000010	
14,000	.000643	.000050	.000050	.000013	
15,000	.000703	.000060	.000063	.000013	
16,000	.000770	.000067	.000077	.000014	
17,000	.000840	.000070	.000097	.000020	Elastic limit.
18,000	.000930	.000090	000180	.000033	
19,000	.001003	.000073	.000157	.000027	
20,000	.001093	.000090	.000180	.000037	
21,000	.001213	.000120	.000243	.000063	
22,000	.001333	.000120	.000297	.000054	
23,000	.001500	.000167	.000397	.000100	
24,000	.001673	.000173	.000510	.000113	
25,000	.001976	.000313	.000740	.000230	
26,000	.002313	.000337	.001000	.000260	
27,000	.002857	.000544	.001437	.000437	
28,000	....	....	....	....	Ultimate strength.

Sustained the maximum load ½ minute before fracturing.

General summary.

Tensile strength per square inch of original section	pounds	28,000
Elastic limit per square inch of original section	do	17,000
Elongation per inch after rupture	inch	0.001667
Elongation per inch under strain at elastic limit	do	.000840
Reduction in diameter at point of rupture		not perceptible.
Reduction in area after rupture		not perceptible.
Position of rupture		8¼″ from neck.
Character of broken surface		coarse, granular.

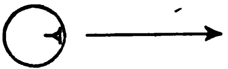
No. 302.

Compression test.

Mark on bar V
Length, 10″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	....	....	Initial load.
1,000	.000020	.000020	0.	....	
2,000	.000030	.000010	0.	....	
3,000	.000080	.000050	0.	....	
4,000	.000120	.000040	0.	....	
5,000	.000160	.000040	0.	....	
6,000	.000200	.000040	0.	....	
7,000	.000250	.000050	.000020	.000020	
8,000	.000280	.000030	.000020	0.	
9,000	.000330	.000050	.000020	0.	
10,000	.000380	.000050	.000020	0.	
11,000	.000420	.000040	.000020	0.	
12,000	.000470	.000050	.000020	0.	
13,000	.000510	.000040	.000020	0.	
14,000	.000560	.000050	.000030	.000010	
15,000	.000610	.000050	.000030	0.	
16,000	.000670	.000060	.000030	0.	
17,000	.000710	.000040	.000040	.000010	
18,000	.000760	.000050	.000040	0.	
19,000	.000810	.000050	.000050	.000010	
20,000	.000860	.000050	.000050	0.	Elastic limit.
21,000	.000910	.000050	.000060	.000010	
22,000	.000970	.000060	.000080	.000020	
23,000	.001030	.000060	.000090	.000010	
24,000	.001090	.000060	.000100	.000010	
25,000	.001180	.000090	.000120	.000020	
26,000	.001240	.000060	.000140	.000020	
27,000	.001310	.000070	.000160	.000020	
28,000	.001390	.000080	.000190	.000030	
29,000	.001490	.000100	.000230	.000040	
30,000	.001670	.000180	.000340	.000110	
31,000	.001760	.000090	.000390	.000050	
32,000	.001900	.000140	.000490	.000100	
33,000	.002100	.000200	.000660	.000170	
34,000	.002350	.000250	.000830	.000170	
35,000	.002680	.000330	.001140	.000310	
36,000	.003050	.000370	.001500	.000360	
37,000	.003550	.000500	.001970	.000470	
38,000	.004130	.000580	.002510	.000540	
39,000	.004700	.000570	.003110	.000600	
40,000	.005520	.000820	.003970	.000860	
40,800	....	....	....	....	Ultimate strength.

Failed by triple flexure.

Direction of middle deflection with reference to distinguishing number  on end of specimen.

There was no perceptible deflection when examined with a straight edge until the maximum load, 40,800 pounds, was reached. The deflection took place gradually.

General summary.

Elastic limit per square inch of original section.........................pounds.. 20,000
Compression per inch under strain at elastic limit.........................inch.. 0.000860
Compression per inch under 40,000 pounds per square inch.........................do.... .005520

No. 303.

Compression test.

Marks on bar, VI.
Length, 10″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	....	....	Initial load.
1,000	.000020	.000020	....	....	
2,000	.000070	.000050	.000020	.000020	
3,000	.000130	.000060	.000050	.000030	
4,000	.000170	.000040	.000040	—.000010	
5,000	.000200	.000030	.000020	—.000020	
6,000	.000230	.000030	.000020	0.	
7,000	.000280	.000050	.000010	—.000010	
8,000	.000300	.000020	.000010	0.	
9,000	.000340	.000040	.000010	0.	
10,000	.000390	.000050	.000020	.000010	
11,000	.000420	.000030	.000030	.000010	
12,000	.000470	.000050	.000020	—.000010	
13,000	.000540	.000070	.000030	.000010	
14,000	.000580	.000040	.000020	—.000010	
15,000	.000640	.000060	.000020	0.	
16,000	.000680	.000040	.000020	0.	
17,000	.000740	.000060	.000040	.000020	
18,000	.000790	.000050	.000040	0.	Elastic limit.
19,000	.000840	.000050	.000050	.000010	
20,000	.000890	.000050	.000060	.000010	
21,000	.000950	.000060	.000070	.000010	
22,000	.001000	.000050	.000090	.000020	
23,000	.001070	.000070	.000100	.000010	
24,000	.001160	.000090	.000110	.000010	
25,000	.001220	.000060	.000140	.000030	
26,000	.001310	.000090	.000170	.000030	
27,000	.001410	.000100	.000210	.000040	
28,000	.001500	.000090	.000260	.000050	
29,000	.001640	.000140	.000330	.000070	
30,000	.001790	.000150	.000410	.000080	
31,000	.001970	.000180	.000590	.000180	
32,000	.002600	.000290	.000810	.000220	
33,000	.002600	.000340	.001100	.000290	
34,000	.003020	.000420	.001520	.000420	
35,000	.003460	.000440	.001920	.000400	Bar began to deflect.
36,000	.004120	.000660	.002580	.000660	
37,000	.005000	.000880	.003440	.000860	
38,800	....	....	....	....	Ultimate strength.

Failed by triple flexure.

Direction of middle deflection

General summary.

Elastic limit per square inch of original section..................................pounds.. 18,000
Compression per inch under strain at elastic limit..................................inch..0.000790
Compression per inch under 34,000 pounds per square inch...... ....do... .003020

No. 307.

Compression test.

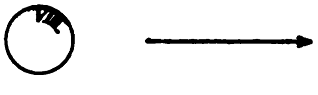
Mark on bar, VIII.
Length, 10″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0	....	....	....	Initial load.
1,000	.000040	.000040	0.	....	
2,000	.000090	.000050	0.	....	
3,000	.000110	.000020	0.	....	
4,000	.000170	.000060	0.	....	
5,000	.000200	.000030	0.	....	
6,000	.000270	.000070	0.	....	
7,000	.000290	.000020	0.	....	
8,000	.000370	.000080	.000010	.000010	
9,000	.000390	.000020	.000010	0.	
10,000	.000470	.000080	.000040	.000030	
11,000	.000490	.000020	.000040	0.	
12,000	.000540	.000050	.000060	.000020	
13,000	.000600	.000060	.000070	.000010	
14,000	.000660	.000060	.000080	.000010	
15,000	.000690	.000030	.000080	0.	
16,000	.000770	.000080	.000080	0.	
17,000	.000800	.000030	.000080	0.	
18,000	.000870	.000070	.000090	.000010	
19,000	.000910	.000040	.000090	0.	
20,000	.000980	.000070	.000100	.000010	
21,000	.001060	.000080	.000110	.000010	
22,000	.001100	.000040	.000110	0.	Elastic limit.
23,000	.001180	.000080	.000140	.000030	
24,000	.001210	.000030	.000170	.000030	
25,000	.001290	.000080	.000180	.000010	
26,000	.001370	.000080	.000190	.000010	
27,000	.001440	.000070	.000200	.000010	
28,000	.001500	.000060	.000270	.000070	
29,000	.001590	.000090	.000280	.000010	
30,000	.001690	.000100	.000300	.000020	
31,000	.001790	.000100	.000380	.000080	
32,000	.001890	.000100	.000410	.000030	Perceptible deflection.
33,000	.002010	.000120	.000490	.000080	
34,000	.002190	.000180	.000600	.000110	
35,000	.002390	.000200	.000740	.000140	
36,000	.002600	.000210	.000930	.000190	
37,000	.002880	.002880	.001100	.000170	
38,000	.003120	.000240	.001340	.000240	
39,000	.003490	.000370	.001670	.000330	
40,000	.003900	.000410	.001990	.000320	
41,000	.004260	.000360	.002360	.000370	
42,000	.004790	.000530	.002790	.000430	
43,000	.005220	.000430	.003580	.000790	Middle deflection, ″.02.
50,500	....	....	....	....	Ultimate strength.

Failed by triple flexure.

When the middle deflection reached ″.40, cracks appeared on the tension side. The load sustained at the time was 40,000 pounds.

Direction of middle deflection



General summary.

Elastic limit per square inch of original section	pounds..	22,000
Compression per inch under strain at elastic limit	inch..	0.001100
Compression per inch under 30,000 pounds per square inch	do...	.001790

No. 310.

Compression test.

CRUSHING.

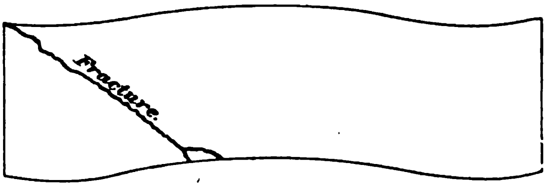
Mark on bar, XIV.
Length, 3''.00.
Diameter, ''.8005.
Sectional area, .503 square inch.

Applied loads.		Increase in diameter at middle.	Successive increase in diameter at middle.	Permanent increase in diameter at middle.	Remarks.
Total.	Per square inch.				
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	
1,006	2,000	0.	....	....	Initial load.
5,030	10,000	0.	....	....	
7,545	15,000	.0001+	.0001+	....	
10,060	20,000	.0002−	.0001−	....	
12,575	25,000	.0002	.0001−	.0000+	
15,090	30,000	.0003	.0001	....	
17,606	35,000	.0006	.0003	....	Diameters measured ½'' from each end.
20,120	40,000	.0010	.0004	....	
23,635	46,000	.0028	.0018	....	*North.* *South.*
25,150	50,000	.0035	.0017	.0028	''.8042+ ''.8042
27,665	55,000	.0049	.0014	....	
30,180	60,000	.0070	.0021	.0063	.8076 .8075
32,696	65,000	.0093	.0023	....	
35,210	70,000	.0121	.0028	....	.8123 .8121
37,725	75,000	.0153	.0032	....	
40,240	80,000	.0190	.0037	.0178	.8182 .8179
42,755	85,000	.0265	.0075	....	Length of specimen, 2.''83. Perceptible buckling. Surface cracks generally developed.
51,100	101,590	....	....	....	Uultimate strength.

Failure occurred by triple flexure.

Pressure was continued till the metal separated at one end with an oblique fracture.

Sketch of Specimen after the test.



No. 311.

Compression test.

CRUSHING.

Mark on bar, XV.
Length, 3″.00.
Diameter, ″.8013.
Sectional area, .504 square inch.

Applied loads.		Increase in diameter at middle.	Successive increase in diameter at middle.	Permanent increase in diameter at middle.	Remarks.	
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	Diameters measured ¼″ from each end.	
1, 008	2, 000	0.	....	....	″. 8013	″. 8026
5, 040	10, 000	. 0001−	. 0001−	....		
7, 560	15, 000	. 0001+	. 0000+	....		
10, 080	20, 000	. 0002	. 0001−	....		
12, 600	25, 000	. 0002+	. 0000+	0.		
15, 120	30, 000	. 0003+	. 0001	....		
17, 640	35, 000	. 0005	. 0002−	....		
20, 160	40, 000	. 0010	. 0005	....		
22, 680	45, 000	. 0022	. 0012	....		
25, 200	50, 000	. 0038	. 0016	. 0032	. 8045	. 8056
27, 720	55, 000	. 0054	. 0016	....		
30, 240	60, 000	. 0073	. 0019	. 0068	. 8076	. 8086
32, 760	65, 000	. 0095	. 0022	....		
35, 280	70, 000	. 0125	. 0030	. 0118	. 8124	. 8136
37, 800	75, 000	. 0157	. 0032	....		
40, 320	80, 000	. 0197	. 0040	. 0187	. 8184	. 8195
42, 840	85, 000	. 0243	. 0046	....	Length of specimen, 2″.84. Fine surface cracks developed.	
45, 360	90, 000	. 0299	. 0056	....		
51, 100	101, 890	....	....	....	Ultimate strength.	

Failed by triple flexure.
Test discontinued when specimen was reduced in length to 2″.58.

No. 312.

Compression test.

CRUSHING.

Mark on bar, XVI.
Length, 3″.00.
Diameter, ″.8005.
Sectional area, .503 square inch.

Applied loads.		Increase in diameter at middle.	Successive increase in diameter at middle.	Permanent increase in diameter at middle.	Remarks.
Total.	Per square inch.				
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	Diameters measured ¼″ from each end.
1,006	2,000	0.	0.	....	″.8005 ″.8019
5,030	10,000	0.	0.	....	
7,545	15,000	.0001	.0001	....	
10,060	20,000	.0001	0.	....	
12,575	25,000	.0002−	.0001−	0.	
15,090	30,000	.0002	.0000+	....	
17,605	35,000	.0005	.0003	....	
20,120	40,000	.0012	.0007	....	
22,635	45,000	.0027	.0015	....	
25,150	50,000	.0047	.0020	.0041	.8045 .8056
27,665	55,000	.0068	.0021	....	
30,180	60,000	.0098	.0025	.0067	.8086 .8096
32,695	65,000	.0124	.0031	....	
35,210	70,000	.0159	.0035	.0151	.8143 .8157
37,725	75,000	.0199	.0040	....	
40,240	80,000	.0252	.0053	....	Length of specimen, 2″.88. Fine surface cracks developed.
48,800	....	....	....	....	Total length, 2″.65.
49,900	99,200	....	....	....	Total length, 2.″58. Ultimate strength.

Failed by triple flexure.

Pressure continued after passing the maximum load, increasing the deflection till an oblique fracture separated the bar at one end, similar to the fracture of bar marked XIV.

No. 1.

Transverse test.

Mark on bar IX.
Diameter, 1″.129.
Sectional area, 1 square inch.
Supported at ends 20″ apart.
Loaded at middle.
Width of middle bearing, 1″.

Applied loads.		Deflection.	Deflection set.	Remarks.
Total.	Maximum fiber strain.			
Pounds.		*Inch.*	*Inch.*	
0	0.	0.	....	
282	10.000	.0331	.0040	Maximum fiber strain computed by the formula— $R=\frac{P\,l}{\pi\,r^3}$
565	20.000	.0622	.0062	
847	30.000	.0898	.0078	
1,130	40.000	.1242	.0138	
1,412	50.000	.1755	.0367	
1,694	60.000	.2886	.1018	
1,977	70.000	.5576	....	
2,118	75.000	.8183	....	Breaking load.

Fractured on the tension side $\frac{7}{8}$″ from the middle of the bar.

No. 2.

Transverse test.

Mark on bar X.
Diameter, 1″.129.
Sectional area, 1 square inch.
Supported at ends 20″ apart.
Loaded at middle.
Width of middle bearing, 1″.

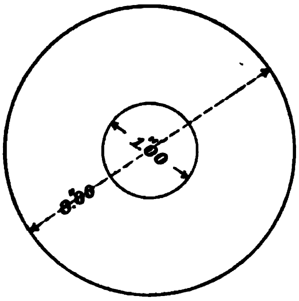
Applied loads.		Deflection.	Deflection set.	Remarks.
Total.	Maximum fiber strain.			
Pounds.		*Inch.*	*Inch.*	
0	0.	0.	....	
282	10.000	.0313	.0021	
565	20.000	.0608	.0041	
847	30.000	.0909	.0060	
1,130	40.000	.1212	.0158	
1,412	50.000	.1724	.0384	
1,694	60.000	.2653	.0968	
1,795	63.540	....	....	Breaking load.

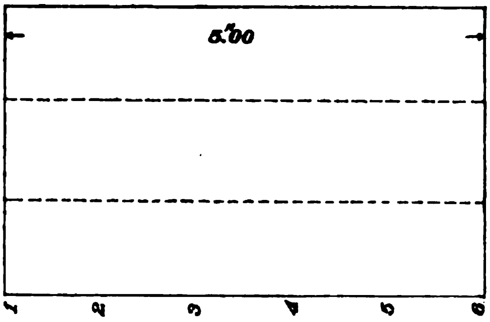
Fractured on the tension side opposite the middle bearing.

No. 1.

Tangential test.

Mark on cylinder XI.





Length of cylinder exposed to internal pressure, 4″.
Cylinder and reservoir charged with mixture of bees-wax 4, tallow 1.
Volume of wax and tallow in cylinder, 3.06 cubic inches.
Volume of wax and tallow in reservoir, 3.65 cubic inches.
Diameter of reservoir piston, 1″.145.
Sectional area of reservoir piston, 1.03 square inches.

Applied loads on piston of reservoir.		Piston move-ment.	Enlargement of diameters of cylinder.					
Total.	Per square inch.		1.	2.	3.	4.	5.	6.
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1,030	1,000	0.	0.	0.	0.	0.	0.	0
2,060	2,000	.02	0.	0.	0.	0.	0.	0.
3,090	3,000	.04	0.	0.	0.	0.	0.	0.
4,120	4,000	.05	0.	0.	0.	0.	0.	0.
5,150	5,000	.06½	0.	0.	0.	0.	0.	0.
6,180	6,000	.08½	0.	0.	0.	0.	0.	0.
7,210	7,000	.11	0.	0.	0.	0.	0.	0.
8,240	8,000	.12	0.	0.	0.	0.	0.	0.
9,270	9,000	.13+	0.	0.	0.	0.	0.	0.
10,300	10,000	.14½	.0000	.0000	.0002	.0003	.0000	.0000
1,030	1,000	.05½	0.	0.	0.	0.	0.	0.
11,330	11,000	.15½	0.	0.	.0002	.0003	0.	0.
12,360	12,000	.17	0.	0.	.0002	.0003	0.	0.
13,390	13,000	.19	0.	.0002	.0005	.0005	0.	0.
Rested 15 hours under no load.								
14,420	14,000	.19	.0002	.0002	.0005	.0005	0.	0.
15,450	15,000	.23	.0002	.0003	.0008	.0008	.0002	0.
1,030	1,000	.07	.0005	.0005	.0006	.0006	.0002	0.
16,480	16,000	.23	.0008	.0008	.0010	.0010	.0006	0.
17,510	17,000	.25	.0008	.0008	.0011	.0010	.0007	0.
Rested 1 hour under no load.								
18,540	18,000	.27	.0007	.0008	.0012	.0011	.0007	0.
19,570	19,000	.27	.0008	.0010	.0011	.0010	.0007	0.
20,600	20,000	.27½	.0009	.0010	.0012	.0011	.0008	0.
1,030	1,000	.07½	.0006	.0005	.0008	.0007	.0002	0.
22,660	22,000	.29	.0009	.0010	.0013	.0012	.0010	0.
24,720	24,000	.31½	.0010	.0011	.0012	.0013	.0008	0.
26,780	26,000	.33	.0009	.0010	.0014	.0013	.0009	0.
28,840	28,000	.35	.0008	.0010	.0018	.0016	.0009	0.
30,900	30,000	.36	.0005	.0009	.0018	.0017	.0008	0.
1,030	1,000	.10	.0003	.0006	.0010	.0008	.0004	0.
32,960	32,000	.36	....	....	....	....	....	....
35,020	34,000	.38	....	....	....	....	....	....
1,030	1,000	....	.0008	.0007	.0010	.0007	.0005	0.
37,080	36,000	.37½	....	....	....	....	....	....
39,140	38,000	.40	....	....	....	....	....	....

Applied loads on piston of reservoir.		Piston movement.	Enlargement of diameters of cylinder.					
Total.	Per square inch.		1.	2.	3.	4.	5.	6.
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
41, 200	40, 000	.42	....	....	....	....	....	....
43, 260	42, 000	.43	....	....	....	....	....	....
45, 320	44, 000	.43½	....	....	....	....	....	....
47, 380	46, 000	.45	....	....	....	....	....	....
49, 440	48, 000	.46	....	....	....	....	....	....
51, 500	50, 000	.47	....	....	....	....	....	....
1, 030	1, 000	.08	.0006	.0008	.0013	.0011	.0006	0.
53, 560	52, 000	.47	....	....	....	....	....	....
55, 620	54, 000	.49	....	....	....	....	....	....
57, 680	56, 000	.50	....	....	....	....	....	....
59, 740	58, 000	.51	....	....	....	....	....	....
61, 800	60, 000	.52	....	....	....	....	....	....
63, 860	62, 000	.53	....	....	....	....	....	....
65, 920	64, 000	.54	....	....	....	....	....	....
80, 000	77, 610	.59	....	....	....	....	....	....
0	0	....	.0007	.0011	.0015	.0013	.0008	0.
51, 500	50, 000	.47	.0004	.0016	.0021	.0021	.0013	0.
95, 000	92, 230	....	....	....	....	....	....	....
106, 000	102, 910	....	....	....	....	....	....	....
1, 030	1, 000	.18	.0005	.0014	.0021	.0020	.0010	0.

Test discontinued.

Cylinder removed from the attachment, and the reservoir piston loaded to determine the resistance of the copper packing or wax check after having been expanded during the test.

It was found that 2,000 pounds per square inch overcame the packing resistance, and caused flow of the wax through the $\frac{3}{16}$-inch vent at the bottom of the reservoir chamber.

The vent was now sealed, and the piston loaded for the purpose of determining the piston movement when compressing only the wax in the reservoir, with the following results:

Applied loads on piston of reservoir.		Piston movement.	Remarks.
Total.	Per square inch.		
Pounds.	*Pounds.*	*Inch.*	
....	1, 000	0.	Initial load.
....	10, 000	.06	
....	15, 000	.10	
....	20, 000	.13	
Load released and vent opened, allowing slight escape of wax. Vent sealed and piston again loaded.			
....	1, 000	0.	Initial load.
....	20, 000	.13	
....	30, 000	.18	
....	40, 000	.23	
....	50, 000	.27	
....	1, 000	.04	

The wax and tallow now removed from the cylinder and reservoir, and the further use of this mixture as a straining material discontinued.

The cylinder was again placed in the attachment for testing, and both cylinder and reservoir now charged with sperm oil. To prevent the oil being forced through the pores of the cast-iron cylinder, a beeswax lining was used. Cup-leather packing was used with the piston of the reservoir.

A load of 34,000 pounds per square inch was applied to the piston when the leather packing blew out; there was ″.01 clearance of the piston in the reservoir chamber.

Measurements now taken on the cylinder showed the following enlargement of diameters under zero load:

1.	2.	3.	4.	5.	6.
Inch. .0003	*Inch.* .0010	*Inch.* .0019	*Inch.* .0015	*Inch.* .0005	*Inch.* —.0001

The reservoir chamber was rebored, increasing its diameter to 1″.17, and refitted with a piston which closely fitted its bore.

The cast-iron cylinder was again subjected to pressure, using water as the straining fluid, and the following measurements taken:

Applied loads on piston of reservoir.		Enlargement of diameters.						Remarks.
Total.	Per square inch.	1.	2.	3.	4.	5.	6.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
5,375	5,000	.0003	.0014	.0021	.0019	.0010	—.0001	
....	10,000	....	....	.0022	......	....	....	
....	15,000	....	....	.0023	....	....	....	
....	20,000	....	....	.0027	....	....	....	
....	25,000	....	....	.0030	....	....	....	
....	5,000	.0003	.0015	.0023	.0021	.0011	—.0001	
....	30,000	....	....	....	....	....	....	
....	5,000	.0007	.0012	.0023	.0020	.0010	—.0002	
40,000	37,210	....	....	....	....	....	....	Leaking badly. Load sustained ½ minute, when supply of water was exhausted.
0	0	.0010	.0016	.0031	.0034	.0017	.0002	

The cylinder was covered with canvas, when 30,000 pounds per square inch pressure was applied; also when the load was increased to 37,210 pounds per square inch.

The reservoir was again charged with water. Under 10,000 pounds per square inch pressure a fine spray was forced through the wall of the cylinder near the middle of its length. Without applying further pressure to the reservoir piston, weeping of the cylinder continued till the internal pressure fell to 3,000 pounds per square inch.

Then rapidly loading the piston, a pressure of 30,000 pounds per square inch was obtained; but the leakage again overcame the pump, and pressure immediately fell.

Uncovering the cylinder, an irregular fissure was found extending about 1 inch in length along the middle of the length of the cylinder. This fissure nearly closed when the cylinder was not strained.

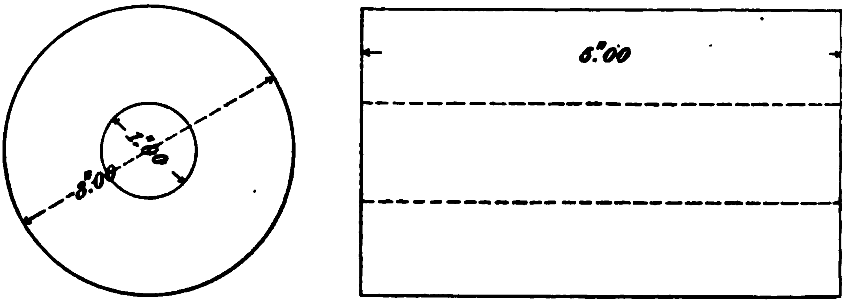
Charging the reservoir and cylinder with glycerine instead of water, a pressure of 27,860 pounds per square inch was reached, when there was sudden yielding, unaccompanied, however, by any sound of rupture.

When examined after the test, the fissure on the exterior surface of the cylinder could be followed a length of 1¾ inches, and in the bore a length of 1 inch.

No. 2.

Tangential test.

Marks on cylinder, XII.



Length of cylinder exposed to internal pressure 4¼″.
Cylinder and reservoir charged with glycerine without using a lining.
Diameter of reservoir piston, 1″.17.
Sectional area of reservoir piston, 1.075 square inches.

Applied loads on piston of reservoir.		Enlargement of diameters of cylinder.			Remarks.
Total.	Per square inch.	Reservoir end.	Middle.	Lower end.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	
1,075	1,000	0.	0.	0.	Initial load.
5,375	5,000	0.	0.	0.	
10,750	10,000	.0001	.0001+	.0001	
12,900	12,000	.0002+	.0003	.0002	
16,125	15,000	.0063	.0004	.0003	
19,350	18,000	.0003+	.0004+	.0003+	
21,500	20,000	.0004	.0006	.0004	
23,650	22,000	.0004+	.0007+	.0004+	
26,875	25,000	.0006	.0011	.0006	
30,100	28,000	.0006	.0017	.0008	Ultimate strength.

The cylinder failed by opening an irregular fissure about 2 inches long, extending from near the middle towards the reservoir end in the plane in which the diameters were measured.

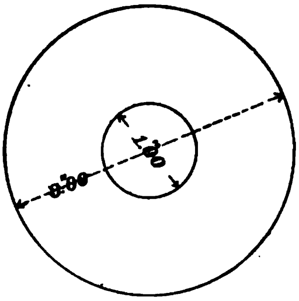
The cylinder was sustaining the maximum load (28,000 pounds per square inch) while the final diameters were measured. On account of the enlargement taking place perpendicular to the plane of these measurements, the progress of failure was more rapid than the diameters indicate.

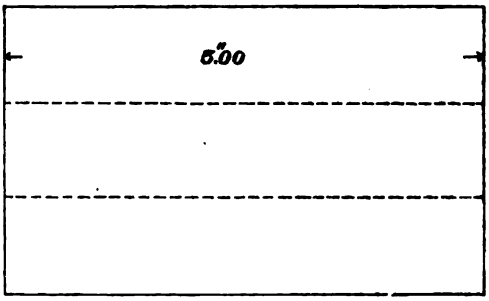
After removal from the testing machine the line of rupture closed and was barely perceptible on the exterior surface; at the bore it could be more readily traced.

No. 3.

Tangential test.

Marks on cylinder, XIII.





Length of cylinder exposed to internal pressure, 4¼″.
Cylinder and reservoir charged with glycerine without using a lining.
Diameter of reservoir piston, 1″.17.
Sectional area of reservoir piston, 1.075 square inch.

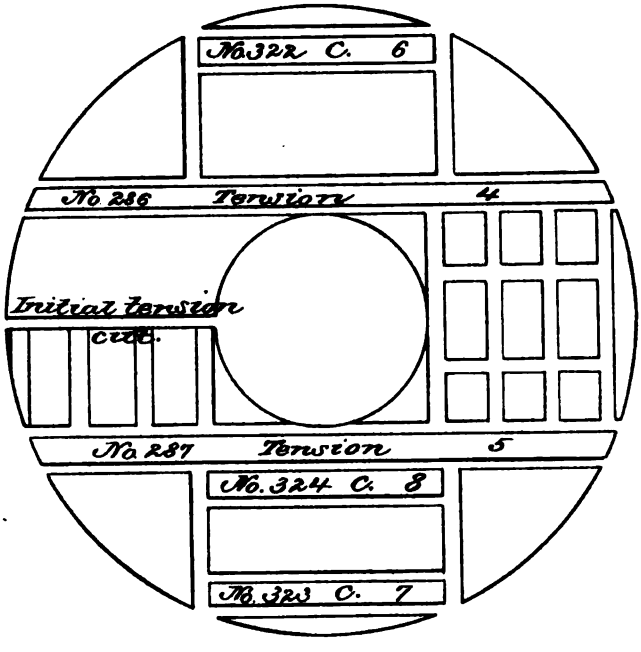
Applied loads on piston of reservoir.		Enlargement of diameters of cylinder.			Remarks.
Total.	Per square inch.	Reservoir end.	Middle.	Lower end.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	
1, 075	1, 000	0.	0.	0.	Initial load.
5, 375	5, 000	0.	0.	0.	
10, 750	10, 000	0.	.0002	0.	
12, 900	12, 000	0.	.0002	0.	
16, 125	15, 000	0.	.0002	0.	
19, 350	18, 000	.0002	.0005	.0002	
21, 500	20, 000	.0006	.0014	.0006	
23, 650	22, 000	.0008	.0016	.0008	
26, 875	25, 000	.0010	.0020	.0010	
30, 100	28, 000	.0014	.0026	.0012	
30, 250	30, 000	....	....	....	Ultimate strength.

The cylinder burst into halves with a sharp but not loud report just as the pressure, which was being gradually increased, had reached 30,000 pounds per square inch.

The line of rupture was irregular, and oblique to the axis of the cylinder, making with it an angle of about 6 degrees.

Cast (gun) iron, from 12 inch Mortar

Initial tension and specimen ring



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Cast (gun) iron from 12″ mortar.

[Cast by South Boston Iron Works.]

No. 286.

Tension test.

Mark on bar, 4.
Length, 25″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	0.	....	Initial load.
1,000	.000040	.000040	0.	....	
2,000	.000092	.000052	0.	....	
3,000	.000140	.000048	.000032	.000032	
4,000	.000232	.000092	.000032	0.	
5,000	.000276	.000044	.000036	.000004	
6,000	.000344	.000068	.000080	.000044	
7,000	.000448	.000104	.000088	.000008	
8,000	.000528	.000080	.000088	0.	
9,000	.000584	.000056	.000088	0.	
10,000	.000652	.000068	.000092	.000004	
11,000	.000712	.000060	.000092	0.	
12,000	.000776	.000064	.000096	.000004	
13,000	.000836	.000060	.000100	.000004	
14,000	.000912	.000076	.000104	.000004	Elastic limit.
15,000	.000984	.000072	.000172	.000068	
16,000	.001124	.000140	.000184	.000012	
17,000	.001208	.000084	.000208	.000024	
18,000	.001304	.000096	.000228	.000020	
19,000	.001408	.000104	.000264	.000036	
20,000	.001521	.000113	.000308	.000044	
21,000	.001652	.000131	.000364	.000056	
22,000	.001792	.000140	.000420	.000056	
23,000	.001936	.000144	.000504	.000084	
24,000	.002124	.000188	.000612	.000108	
25,000	.002344	.000220	.000752	.000140	
25,980	....	....	....	....	Ultimate strength.

General summary.

Specific gravity		7.252
Hardness		12.96
Tensile strength per square inch of original section	pounds	25,980
Elastic limit per square inch of original section	do	14,000
Elongation per inch under strain at elastic limit	inch	0.000912
Position of rupture		3½″ from middle of bar.
Character of broken surface		coarse granular; defective; metal at circumference of fractured surface—cinder spot.

No. 287.

Tension test.

Mark on bar, 5.
Length, 24″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	0.	....	Initial load.
1,000	.000021	.000021	0.	....	
2,000	.000075	.000054	0.	....	
3,000	.000137	.000062	0.	....	
4,000	.000179	.000042	0.	....	
5,000	.000233	.000054	0.	....	
6,000	.000287	.000054	0.	....	
7,000	.000346	.000059	0.	....	
8,000	.000408	.000062	.000013	.000013	
9,000	.000471	.000063	.000017	.000004	
10,000	.000529	.000058	.000029	.000012	
11,000	.000596	.000067	.000038	.000009	
12,000	.000667	.000071	.000046	.000008	
13,000	.000758	.000091	.000083	.000037	
14,000	.000825	.000067	.000088	.000005	Elastic limit.
15,000	.000904	.000079	.000112	.000024	
16,000	.000971	.000067	.000129	.000017	
17,000	.000058	.000087	.000150	.000021	
18,000	.001154	.000096	.000175	.000025	
19,000	.001258	.000104	.000204	.000029	
20,000	.001350	.000092	.000254	.000050	
21,000	.001467	.000117	.000204	.000050	
22,000	.001596	.000129	.000246	.000042	
23,000	.001754	.000158	.000325	.000079	
24,000	.001933	.000179	.000425	.000100	
25,000	.002158	.000225	.000554	.000129	
26,000	.002450	.000292	.000808	.000254	
27,000	.002721	.000271	.000958	.000150	
27,900	....	....	....	....	Ultimate strength.

General summary.

Tensile strength per square inch of original section	pounds..	27,900
Elastic limit per square inch of original section	do....	14,000
Elongation per inch under strain at elastic limit	inch..	0.000825
Position of rupture		2 inches from middle of bar.
Character of broken surface		coarse granular.

No. 322.

Compression test.

Mark on bar, 6.
Length, 10''.
Diameter, 1''.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	0.	....	Initial load.
1, 000	.000040	.000040	0.	....	
2, 000	.000090	.000050	0.	....	
3, 000	.000130	.000040	0.	....	
4, 000	.000180	.000050	0.	....	
5, 000	.000210	.000030	0.	....	
6, 000	.000290	.000080	0.	....	
7, 000	.000310	.000020	0.	....	
8, 000	.000390	.000080	0.	....	
9, 000	.000410	.000020	.000010+	.000010+	
10, 000	.000480	.000070	.000020	.000010−	
11, 000	.000520	.000040	.000040	.000020	
12, 000	.000600	.000080	.000050	.000010	
13, 000	.000640	.000040	.000060	.000010	
14, 000	.000710	.000070	.000080	.000020	
15, 000	.500790	.000080	.000090	.000010	
16, 000	.000810	.000020	.000090	0.	
17, 000	.000880	.000070	.000100	.000010	
18, 000	.000950	.000070	.000100	0.	
19, 000	.001010	.000060	.000110	.000010	
20, 000	.001090	.000080	.000130	.000020	
21, 000	.001140	.000050	.000150	.000020	
22, 000	.001200	.000060	.000160	.000010	
23, 000	.001280	.000080	.000180	.000020	
24, 000	.001350	.000070	.000200	.000020	
25, 000	.001420	.000070	.000210	.000010	
26, 000	.001510	.000090	.000250	.000040	
27, 000	.001600	.000090	.000290	.000040	
28, 000	.001700	.000100	.000330	.000040	
29, 000	.001790	.000090	.000390	.000060	
30, 000	.001900	.000110	.000440	.000050	
31, 000	.002010	.000110	.000510	.000070	
32, 000	.002190	.060180	.000610	.000100	
33, 000	.002310	.000120	.000730	.000120	
34, 000	.002560	.000250	.000890	.000160	
35, 000	.002790	.000230	.001100	.000210	
36, 000	.003040	.000250	.001290	.000190	Deflection perceptible.
37, 000	.003360	.000320	.001600	.000310	
38, 000	.003700	.000340	.001820	.000220	Micrometer removed; deflection at middle, ''.01 ±.
46, 200	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under maximum load, ''.17.

No. 323.

Compression test.

Mark on bar, 7.
Length, 10″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	0.	....	Initial load.
1,000	.000050	.000050	.000020	.000020	
2,000	.000090	.000040	.000030	.000010	
3,000	.000150	.000060	.000030	0.	
4,000	.000200	.000050	.000040	.000010	
5,000	.000240	.000040	.000040	0.	
6,000	.000290	.000050	.000040	0.	
7,000	.000370	.000080	.000070	.000030	
8,000	.000420	.000050	.000070	0.	
9,000	.000480	.000060	.000080	.000010	
10,000	.000510	.000030	.000100	.000020	
11,000	.000570	.000060	.000100	0.	
12,000	.000630	.000060	.000100	0.	
13,000	.000690	.000060	.000110	.000010	
14,000	.000750	.000060	.000110	0.	
15,000	.000800	.000050	.000130	.000020	
16,000	.000880	.000080	.000150	.000020	
17,000	.000930	.000050	.000160	.000010	
18,000	.001010	.000080	.000170	.000010	
19,000	.001070	.000060	.000180	.000010	
20,000	.001110	.000040	.000200	.000020	
21,000	.001190	.000080	.000210	.000010	
22,000	.001250	.000060	.000220	.000010	
23,000	.001320	.000070	.000240	.000020	
24,000	.001400	.000080	.000260	.000020	
25,000	.001480	.000080	.000290	.000030	
26,000	.001540	.000060	.000300	.000010	
27,000	.001620	.000080	.000320	.000020	
28,000	.001720	.000100	.000380	.000060	
29,000	.001820	.000100	.000420	.000040	
30,000	.001920	.000100	.000450	.000030	
31,000	.002020	.000100	.000510	.000060	
32,000	.002170	.000150	.000610	.000100	
33,000	.002320	.000150	.000700	.000090	
34,000	.002490	.000170	.000820	.000120	Deflection perceptible.
35,000	.002720	.000230	.001020	.000200	
36,000	.002920	.000200	.001160	.000140	
37,000	.003090	.000170	.001330	.000170	
38,000	.003350	.000260	.001500	.000170	Micrometer removed.
47,200	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under the maximum load, ″.07.

No. 324.

Compression test.

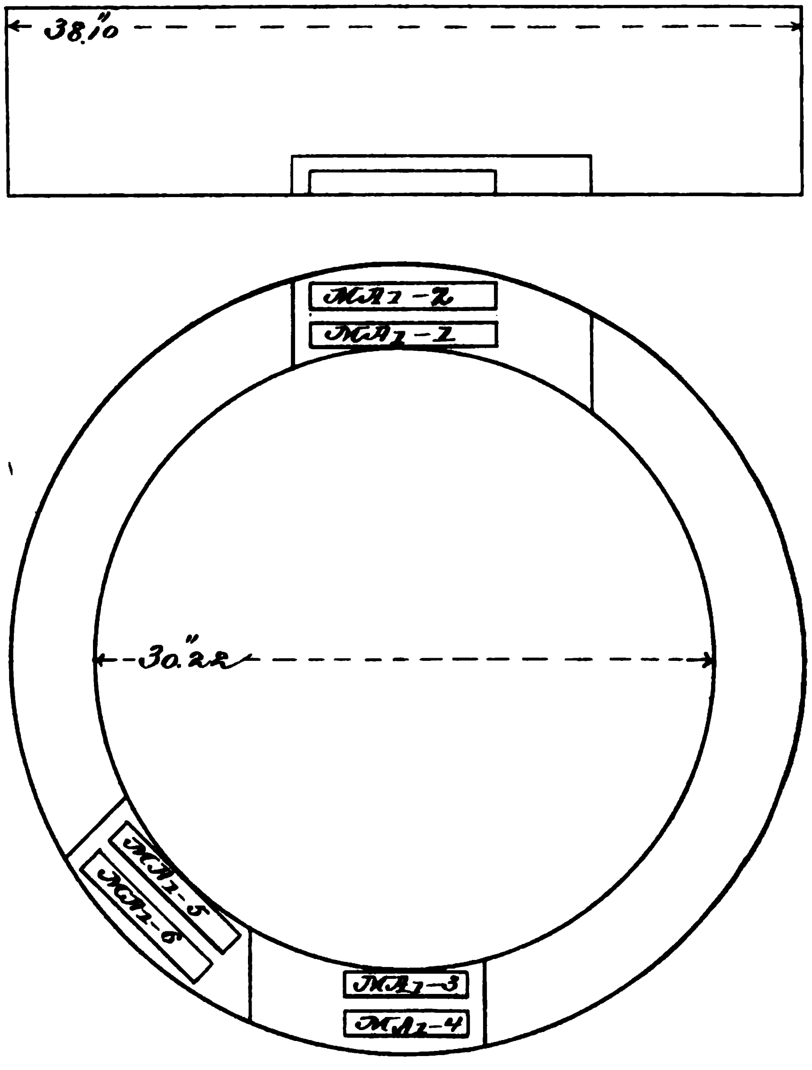
Mark on bar, 8.
Length, 10″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	0.	....	0.	....	Initial load.
1, 000	.000030	.000030	0.	....	
2, 000	.000080	.050050	.000020	.000020	
3, 000	.000130	.000050	.000020	0.	
4, 009	.000170	.000040	.000020	0.	
5, 000	.000220	.000050	.000020	0.	
6, 000	.000260	.000040	.000020	0.	
7, 000	.000310	.000050	.000020	0.	
8, 000	.000380	.000070	.000020	0.	
9, 000	.000410	.000030	.000020	0.	
10, 000	.000470	.000160	.000030	.000010	
11, 000	.000520	.000050	.000040	.000010	
12, 000	.000570	.000050	.000050	.000010	
13, 000	.000630	.000060	.000060	.000010	
14, 000	.000670	.000040	.000060	0.	
15, 000	.000740	.000070	.000070	.000010	
16, 000	.000790	.000050	.000080	.000010	
17, 000	.000850	.000060	.000080	0.	
18, 000	.000910	.000060	.000090	.000010	
19, 000	.000970	.000060	.000100	.000010	
20, 000	.001030	.000060	.000110	.009010	
21, 000	.001090	.000060	.000120	.000010	
22, 000	.001150	.000060	.000130	.000010	
23, 000	.001200	.000050	.000150	.000020	
24, 000	.001280	.000080	.000160	.000010	
25, 000	.001340	.000060	.000180	.000020	
26, 000	.001420	.000080	.000200	.000020	
27, 000	.001490	.000070	.000220	.000020	
28, 000	.001560	.000070	.000230	.000010	
29, 000	.001640	.000080	.000260	.000030	
30, 000	.001720	.000080	.000290	.000030	
31, 000	.001810	.000090	.000320	.000030	
32, 000	.001900	.000090	.000370	.000050	
33, 000	.002000	.000100	.000420	.000050	
34, 000	.002110	.000110	.000490	.000070	
35, 000	.002250	.000140	.000530	.000040	
36, 000	.002380	.000130	.000630	.000100	
37, 000	.002530	.000150	.000730	.000100	
38, 000	.002730	.000200	.000860	.000130	
39, 000	.002940	.000210	.001030	.000170	
40, 000	.003190	.000250	.001230	.000200	
41, 000	.003430	.000240	.001430	.000200	
42, 000	.003700	.000270	.001670	.000240	
43, 000	.004090	.000390	.001950	.000280	
44, 000	.004470	.000380	.002320	.000370	Deflection perceptible.
45, 000	.004980	.000510	.002830	.000510	
46, 000	.005510	.000530	.003220	.000390	Micrometer removed.
55, 540	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under maximum load, ″.2±.

Hoop A1
12 inch Mortar

Roller



STEEL TAKEN FROM HOOPS FOR 12" MORTAR.

[From the Midvale Steel Works.—Oil tempered and annealed.]

No. 260.

Tension test.

Marks on bar, M A 1-1.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000133	.000133	0.	....	
2,500	10,000	.000267	.000134	0.	....	
3,750	15,000	.000433	.000166	.000017	.000017	
5,000	20,000	.000600	.000167	.000017	0.	
6,250	25,000	.000733	.000133	.000017	0.	
6,500	26,000	.000783	.000050	....	....	
6,750	27,000	.000817	.000034	....	....	
7,000	28,000	.000833	.000016	....	....	
7,250	29,000	.000850	.000017	....	....	
7,500	30,000	.000867	.000017	.000017	0.	
7,750	31,000	.000883	.000016	....	....	
8,000	32,000	.000933	.000050	....	....	
8,250	33,000	.000967	.000034	....	....	
8,500	34,000	.001017	.000050	....	....	
8,750	35,000	.001050	.000033	.000017	0.	
9,000	36,000	.001067	.000017	....	....	
9,250	37,000	.001100	.000033	....	....	
9,500	38,000	.001150	.000050	....	....	
9,750	39,000	.001200	.000050	....	....	
10,000	40,000	.001233	.000033	.000017	0.	
10,250	41,000	.001250	.000017	....	....	
10,500	42,000	.001283	.000033	....	....	
10,750	43,000	.001300	.000017	....	....	
11,000	44,000	.001350	.000050	....	....	
11,250	45,000	.001367	.000017	.000033	.000016	
11,500	46,000	.001400	.000033	....	....	
11,750	47,000	.001433	.000033	....	....	
12,000	48,000	.001500	.000067	....	....	
12,250	49,000	.001517	.000017	....	....	
12,500	50,000	.001533	.000016	.000050	.000017	
12,750	51,000	.001567	.000034	....	....	
13,000	52,000	.001617	.000050	....	....	
13,250	53,000	.001650	.000033	....	....	
13,500	54,000	.001683	.000033	....	....	
13,750	55,000	.001700	.000017	.000050	0.	
14,000	56,000	.001717	.000017	....	....	
14,250	57,000	.001767	.000050	....	....	
14,500	58,000	.001817	.000050	....	....	
14,750	59,000	.001867	.000050	....	....	
15,000	60,000	.001900	.000033	.000067	.000017	
15,250	61,000	.001933	.000033	....	....	
15,500	62,000	.002000	.000067	....	....	
15,750	63,000	.002033	.000033	....	....	Elastic limit.
16,000	64,000	.002250	.000217	....	....	
16,250	65,000	.003033	.000783	.000033	.000866	
16,500	66,000	.003967	.000934	....	....	
16,750	67,000	.004717	.000750	....	....	
17,000	68,000	.005667	.000950	....	....	
17,250	69,000	.006450	.000783	....	....	
17,500	70,000	.007350	.000900	.005183	.004250	Micrometer removed.
18,000	72,000	.0100	.002650	....	....	
18,500	74,000	.0125	.0025	....	....	
19,000	76,000	.0142	.0017	....	....	
19,500	78,000	.0167	.0025	....	....	
20,000	80,000	.0183	.0016	....	....	
20,500	82,000	.0200	.0017	....	....	
21,000	84,000	.0217	.0017	....	....	
21,500	86,000	.0233	.0016	....	....	
22,000	88,000	.0267	.0034	....	....	
22,500	90,000	.0300	.0033	....	....	
23,000	92,000	.0333	.0033	....	....	
23,500	94,000	.0358	.0025	....	....	
24,000	96,000	.0383	.0025	....	....	
24,500	98,000	.0433	.0050	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
25, 000	100, 000	.0483	.0050	....	....	
25, 500	102, 000	.0533	.0050	....	....	
26, 000	104, 000	.0617	.0084	....	....	
26, 500	106, 000	.0733	.0116	....	....	
27, 000	108, 000	.0967	.0234	....	....	
27, 300	109, 200	....	....	....	....	Ultimate strength.
22, 100	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	109, 200
Elastic limit per square inch of original section	do....	63, 000
Elongation per inch after rupture	inch..	0. 165
Elongation per inch under strain at elastic limit	do...	.002033
Reduction in diameter at point of rupture	do...	.164
Reduction in area after rupture, per centum of original section		49. 6
Position of rupture		1⅛″ from neck.
Character of broken surface		silky, slightly granular.
Elongation of inch sections		″.14 (″.38 fractured section), ″.13, ″.12, ″.12, ″.10

No. 264.

Tension test.

Marks on bar, M A_1—2.
Length, 6″.
Diameter, ″.564.
Sectional area .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	.000117	.000117	0.	....	
2, 500	10, 000	.000267	.000150	0.	....	
3, 750	15, 000	.000417	.000150	0.	....	
5, 000	20, 000	.000533	.000116	0.	....	
6, 250	25, 000	.000683	.000150	0.	....	
7, 500	30, 000	.000833	.000150	0.	....	
8, 750	35, 000	.000983	.000150	0.	....	
10, 000	40, 000	.001150	.000167	0.	....	
10, 250	41, 000	.001167	.000017	....	....	
10, 500	42, 000	.001200	.000033	....	....	
10, 750	43, 000	.001250	.000050	....	....	
11, 000	44, 000	.001283	.000033	....	....	
11, 250	45, 000	.001317	.000034	0.	....	
11, 500	46, 000	.001333	.000016	....	....	
11, 750	47, 000	.001367	.000034	....	....	
12, 000	48, 000	.001400	.000033	....	....	
12, 250	49, 000	.001433	.000033	....	....	
12, 500	50, 000	.001483	.000050	0.	....	
12, 750	51, 000	.001517	.000034	....	....	
13, 000	52, 000	.001550	.000033	....	....	
13, 250	53, 000	.001583	.000033	....	....	
13, 500	54, 000	.001617	.000034	....	....	
13, 750	55, 000	.001667	.000050	.000017	.000017	
14, 000	56, 000	.001683	.000016	....	....	
14, 250	57, 000	.001717	.000034	....	....	
14, 500	58, 000	.001800	.000083	....	....	
14, 750	59, 000	.001833	.000033	....	....	Elastic limit.
15, 000	60, 000	.001950	.000117	.000150	.000133	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
15, 250	61, 000	.002217	.000267	....	....	
15, 500	62, 000	.003867	.001650	....	....	
15, 750	63, 000	.004483	.000616	....	....	
16, 000	64, 000	.005850	.001367	....	....	
16, 250	65, 000	.006117	.000267	.003850	.003700	
16, 500	66, 000	.007167	.001050	....	....	
16, 750	67, 000	.007633	.000466	....	....	
17, 000	68, 000	.008617	.000984	....	....	
17, 250	69, 000	.009283	.000666	....	....	
17, 500	70, 000	.010350	.001067	.007783	.003933	Micrometer removed.
18, 000	72, 000	.0117	.001350	....	....	
18, 500	74, 000	.0133	.0016	....	....	
19, 000	76, 000	.0167	.0034	....	....	
19, 500	78, 000	.0175	.0008	....	....	
20, 000	80, 000	.0200	.0025	....	....	
20, 500	82, 000	.0233	.0033	....	....	
21, 000	84, 000	.0242	.0009	....	....	
21, 500	86, 000	.0258	.0016	....	....	
22, 000	88, 000	.0300	.0042	....	....	
22, 500	90, 000	.0317	.0017	....	....	
23, 000	92, 000	.0358	.0041	....	....	
23, 500	94, 000	.0400	.0042	....	....	
24, 000	96, 000	.0450	.0050	....	....	
24, 500	98, 000	.0500	.0050	....	....	
25, 000	100, 000	.0567	.0067	....	....	
25, 500	102, 000	.0667	.0100	....	....	
26, 000	104, 000	.0833	.0166	....	....	
26, 500	106, 000	.1183	.0350	....	....	
26, 540	106, 160	.1333	.0150	....	....	Ultimate strength.
22, 700	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity	7.8557
Hardness	23.04
Tensile strength per square inch of original section ..... pounds..	106, 160
Elastic limit per square inch of original section ..... do...	59, 000
Elongation per inch after rupture ..... inch..	0.165
Elongation per inch under strain at elastic limit ..... do...	.001833
Reduction in diameter at point of rupture ..... do...	.144
Reduction in area after rupture, per centum of original section	44.4
Position of rupture	2″.8 from neck.
Character of broken surface	granular, radiating from a dull center.
Elongation of inch sections	″.11, ″.16 (″.36 fractured section), ″.14, ″.12, ″.10.

No. 269.

Tension test.

Marks on bar, M. A_1—3.
Length, 3″.
Diameter, ″.560.
Sectional area, .246 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
246	1, 000	0.	....	0.	....	Initial load.
1, 230	5, 000	0.	....	—.000067	—.000067	
2, 460	10, 000	.000133	.000133	—.000067	0.	
3, 690	15, 000	.000300	.000167	—.000067	0.	
4, 920	20, 000	.000433	.000133	—.000067	0.	
6, 150	25, 000	.000567	.000134	—.000067	0.	
7, 380	30, 000	.000733	.000166	—.000067	0.	
8, 610	35, 000	.000900	.000167	—.000067	0.	
9, 840	40, 000	.001000	.000100	— 000067	0.	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10, 086	41, 000	.001000	0.	....	....	
10, 332	42, 000	.001067	.000067	....	....	
10, 578	43, 000	.001133	.000066	....	....	
10, 824	44, 000	.001167	.000034	....	....	
11, 070	45, 000	.001200	.000033	—.000067	0.	
11, 316	46, 000	.001233	.000033	....	....	
11, 562	47, 000	.001267	.000034	....	....	
11, 808	48, 000	.001267	0.	....	....	
12, 054	49, 000	.001300	.000033	....	....	
12, 300	50, 000	.001333	.000033	—.000067	0.	
12, 546	51, 000	.001367	.000034	....	....	
12, 792	52, 000	.001433	.000066	....	....	
13, 038	53, 000	.001467	.000034	....	....	
13, 284	54, 000	.001500	.000033	....	....	
13, 530	55, 000	.001533	.000033	—.000067	0.	
13, 776	56, 000	.001600	.000067	....	....	
14, 022	57, 000	.001633	.000033	....	....	
14, 268	58, 000	.001633	0.	....	....	
14, 514	59, 000	.001667	.000034	....	....	
14, 760	60, 000	.001700	.000033	—.000067	0.	
15, 006	61, 000	.001700	0.	....	....	
15, 252	62, 000	.001767	.000067	....	....	Elastic limit.
15, 498	63, 000	.001900	.000133	....	....	
15, 744	64, 000	.002100	.000200	....	....	
15, 990	65, 000	.003300	.001200	.001167	.001234	
16, 236	66, 000	.004133	.000833	....	....	
16, 482	67, 000	.005133	.001000	....	....	
16, 728	68, 000	.005967	.000834	....	....	
16, 974	69, 000	.006833	.000866	....	....	
17, 220	70, 000	.007967	.001134	.005467	.004300	Micrometer removed.
17, 712	72, 000	.0100	.002033	....	....	
18, 204	74, 000	.0117	.0017	....	....	
18, 696	76, 000	.0133	.0016	....	....	
19, 188	78, 000	.0150	.0017	....	....	
19, 680	80, 000	.0167	.0017	....	....	
20, 172	82, 000	.0200	.0033	....	....	
20, 664	84, 000	.0217	.0017	....	....	
21, 156	86, 000	.0233	.0016	....	....	
21, 648	88, 000	.0250	.0017	....	....	
22, 140	90, 000	.0283	.0033	....	....	
22, 632	92, 000	.0317	.0034	....	....	
23, 124	94, 000	.0350	.0033	....	....	
23, 616	96, 000	.0400	.0050	....	....	
24, 108	98, 000	.0433	.0033	....	....	
24, 600	100, 000	.0500	.0067	....	....	
25, 092	102, 000	.0600	.0100	....	....	
25, 584	104, 000	.0750	.0150	....	....	
26, 076	106, 000	.0933	.0183	....	....	
26, 380	107, 240	.1217	.0284	....	....	Ultimate strength.
21, 200	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	107, 240
Elastic limit per square inch of original section	do....	62, 000
Elongation per inch after rupture	inch..	0. 203
Elongation per inch under strain at elastic limit	do...	.001767
Reduction in diameter at point of rupture	do...	.160
Reduction in area after rupture, per centum of original section		48. 8
Position of rupture		1″.5 from neck.
Character of broken surface		silky, &c., cup-shaped ends.
Elongation of inch sections		″.16 (″.35 fractured section), ″.10

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
19,000	76,000	.008500	.000867	....	....	
19,250	77,000	.009067	.000567	....	....	
19,500	78,000	.010033	.000966	....	....	
19,750	79,000	.010767	.000734	....	....	
20,000	80,000	.011700	.000933	.008567	.003700	
20,500	82,000	.013333	.001633	....	....	
21,000	84,000	.015000	.001667	....	....	
21,500	86,000	.016833	.001833	....	....	
22,000	88,000	.018633	.001800	....	....	
22,500	90,000	.020433	.001800	.016833	.008266	
23,000	92,000	.022100	.001667	....	....	
23,500	94,000	.024367	.002267	....	....	
24,000	96,000	.027100	.002733	....	....	
24,500	98,000	.029500	.001600	....	....	
25,000	100,000	.032333	.002833	.027900	.011067	Micrometer removed.
25,500	102,000	.033333	.001000	....	....	
26,000	104,000	.036667	.003334	....	....	
26,500	106,000	.040000	.003333	....	....	
27,000	108,000	.046667	.006667	....	....	
27,500	110,000	.053333	.006666	....	....	
28,000	112,000	.060000	.006667	....	....	
28,500	114,000	.073333	.013333	....	....	
29,000	116,000	.103333	.030000	....	....	
29,050	116,200	.113333	.010000	....	....	Ultimate strength.
25,900	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section....................................pounds.. 116,200
Elastic limit per square inch of original section.......................................do... 62,000
Elongation per inch after rupture.......................................inch.. 0.178
Elongation per inch under strain at elastic limit.......................................do... .002000
Reduction in diameter at point of rupture.......................................do... .004
Reduction in area after rupture, per centum of original section.......................................do... 30.8
Position of rupture.......................................".35 from middle of stem
Character of broken surface.......................................granular, 70 per cent.; dull smoky center, 30 per cent.

No. 95.

Tension test.

Marks on bar, M A_5—5.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000133	.000133	0.	....	
2,500	10,000	.000317	.000184	0.	....	
3,750	15,000	.000433	.000116	0.	....	
5,000	20,000	.000550	.000117	0.	....	
6,250	25,000	.000683	.000133	0.	....	
7,500	30,000	.000833	.000150	— .000016	— .000016	
8,750	35,000	.001000	.000167	— .000016	0.	
10,000	40,000	.001133	.000133	— .000033	— .000017	
11,250	45,000	.001283	.000150	— .000016	.000017	
12,500	50,000	.001466	.000183	— .000016	0.	
12,750	51,000	.001500	.000034	....	....	
13,000	52,000	.001516	.000016	....	....	
13,250	53,000	.001550	.000034	....	....	
13,500	54,000	.001583	.000033	....	....	
13,750	55,000	.001616	.000033	— .000016	0.	
14,000	56,000	.001650	.000034	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
24, 990	102, 000	.0717	.0117	....	....	
25, 480	104, 000	.0867	.0150	....	....	
25, 850	105, 510	.1567	.0700	....	....	Ultimate strength.
21, 500	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity		7. 8587
Hardness		23. 44
Tensile strength per square inch of original section	pounds..	105, 510
Elastic limit per square inch of original section	do...	58, 000
Elongation per inch after rupture	inch..	0. 21
Elongation per inch under strain at elastic limit	do...	.001967
Reduction in diameter at point of rupture	do...	.159
Reduction in area after rupture, per centum of original section		48. 6
Position of rupture		middle of stem.
Character of broken surface		silky, trace of granulation, cup-shaped ends.
Elongation of inch sections		″.13 (″.38 fractured section), ″.12

No. 284.

Tension test.

Marks on bar, M. A_1—5.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	.000133	.000133	0.	....	
2, 500	10, 000	.000350	.000217	.000017	.000017	
3, 750	15, 000	.000502	.000152	.000017	0.	
5, 000	20, 000	.000667	.000165	.000017	0.	
6, 250	25, 000	.000833	.000166	.000033	.000016	
7, 500	30, 000	.000967	.000134	.000033	0.	
7, 750	31, 000	.001000	.000033	....	....	
8, 000	32, 000	.001033	.000033	....	....	
8, 250	33, 000	.001067	.000034	....	....	
8, 500	34, 000	.001100	.000033	....	....	
8, 750	35, 000	.001167	.000067	.000117	.000084	
9, 000	36, 000	.001200	.000033	....	....	
9, 250	37, 000	.001233	.000033	....	....	
9, 500	38, 000	.001250	.000017	....	....	
9, 750	39, 000	.001283	.000033	....	....	
10, 000	40, 000	.001317	.000034	.000117	0.	
10, 250	41, 000	.001350	.000033	....	....	
10, 500	42, 000	.001367	.000017	....	....	
10, 750	43, 000	.001283	.000016	....	....	
11, 000	44, 000	.001417	.000034	....	....	
11, 250	45, 000	.001450	.000033	.000167	.000050	
11, 500	46, 000	.001533	.000083	....	....	
11, 750	47, 000	.001550	.000017	....	....	
12, 000	48, 000	.001567	.000017	....	....	
12, 250	49, 000	.001600	.000033	....	....	
12, 500	50, 000	.001633	.000033	.000167	0.	
12, 750	51, 000	.001683	.000050	....	....	
13, 000	52, 000	.001700	.000017	....	....	
13, 250	53, 000	.001733	.000033	....	....	
13, 500	54, 000	.001767	.000034	....	....	

No. 96.

Tension test.

Marks on bar, MA$_5$—6.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	....	....	Initial load.
1, 250	5, 000	.000100	.000100	0.	....	
2, 500	10, 000	.000266	.000166	0.	....	
3, 750	15, 000	.000433	.000167	0.	....	
5, 000	20, 000	.000583	.000150	0.	....	
6, 250	25, 000	.000766	.000183	0.	....	
7, 500	30, 000	.000983	.000167	.000017	.000017	
8, 750	35, 000	.001100	.000233	.000017	0.	
10, 000	40, 000	.001233	.000183	.000017	0.	
11, 250	45, 000	.001417	.000184	.000033	.000016	
12, 500	50, 000	.001567	.000150	.000050	.000017	
12, 750	51, 000	.001600	.000033	....	....	
13, 000	52, 000	.001617	.000017	....	....	
13, 250	53, 000	.001650	.000033	....	....	
13, 500	54, 000	.001667	.000017	....	....	
13, 750	55, 000	.001700	.000033	.000066	.000016	
14, 000	56, 000	.001733	.000033	....	....	
14, 250	57, 000	.001766	.000033	....	....	
14, 500	58, 000	.001800	.000034	....	....	
14, 750	59, 000	.001833	.000033	....	....	
15, 000	60, 000	.001867	.000034	.000083	.000017	
15, 250	61, 000	.001900	.000033	....	....	
15, 500	62, 000	.001933	.000033	....	....	
15, 750	63, 000	.001967	.000034	....	....	
16, 000	64, 000	.002000	.000033	....	....	
16, 250	65, 000	.002050	.000050	.000083	0.	
16, 500	66, 000	.002117	.000067	....	....	
16, 750	67, 000	.002150	.000033	....	....	
17, 000	68, 000	.002183	.000033	....	....	Elastic limit.
17, 250	69, 000	.002283	.000100	....	....	
17, 500	70, 000	.002450	.000167	.000350	.000267	
17, 750	71, 000	.002816	.000366	....	....	
18, 000	72, 000	.003267	.000451	....	....	
18, 250	73, 000	.003767	.000500	....	....	
18, 500	74, 000	.004216	.000449	....	....	
18, 750	75, 000	.004966	.000750	.002433	.002083	
19. 000	76, 000	.005883	.000917	....	....	
19, 250	77, 000	.006450	.000567	....	....	
19, 500	78, 000	.007100	.000650	....	....	
19, 750	79, 000	.007783	.000683	....	....	
20, 000	80. 000	.008650	.000867	.005766	.003333	
20, 500	82, 000	.010183	.001533	....	....	
21, 000	84, 000	.011983	.001800	....	....	
21, 500	86, 000	.013600	.001617	....	....	
22, 000	88, 000	.015433	.001833	....	....	
22, 500	90, 000	.017283	.001850	.013750	.007984	Micrometer removed.
23, 000	92, 000	.017500	.000217	....	....	
23, 500	94, 000	.018333	.000833	....	....	
24, 000	96, 000	.020000	.001667	....	....	
24, 500	98, 000	.023333	.003333	....	....	
25, 000	100, 000	.026667	.003334	....	....	
25, 500	102, 000	.030000	.003333	....	....	
26, 000	104, 000	.033333	.003333	....	....	
26, 500	106, 000	.036666	.003333	....	....	
27, 000	108, 000	.038333	.001667	....	....	
27, 500	110, 000	.043333	.005000	....	....	
28, 000	112, 000	.048333	.005000	....	....	
28, 500	114, 000	.055000	.006667	....	....	

No. 285.

Tension test.

Marks on bar, M. A_1—6.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000167	.000167	.000033	.000033	
2,500	10,000	.000333	.000166	.000033	0.	
3,750	15,000	.000500	.000167	.000033	0.	
5,000	20,000	.000617	.000117	.000033	0.	
6,250	25,000	.000800	.000183	.000033	0.	
7,500	30,000	.000950	.000150	.000033	0.	
7,750	31,000	.001000	.000050	....	....	
8,000	32,000	.001017	.000017	....	....	
8,250	33,000	.001033	.000016	....	....	
8,500	34,000	.001050	.000017	....	....	
8,750	35,000	.001117	.000067	.000067	.000034	
9,000	36,000	.001183	.000066	....	....	
9,250	37,000	.001200	.000017	....	....	
9,500	38,000	.001217	.000017	....	....	
9,750	39,000	.001233	.000016	....	....	
10,000	40,000	.001250	.000017	.000067	0.	
10,250	41,000	.001283	.000033	....	....	
10,500	42,000	.001333	.000050	....	....	
10,750	43,000	.001350	.000017	....	....	
11,000	44,000	.001383	.000033	....	....	
11,250	45,000	.001417	.000034	.000067	0.	
11,500	46,000	.001450	.000033	....	....	
11,750	47,000	.001483	.000033	....	....	
12,000	48,000	.001517	.000034	....	....	
12,250	49,000	.001533	.000016	....	....	
12,500	50,000	.001567	.000034	.000067	0.	
12,750	51,000	.001667	.000100	....	....	
13,000	52,000	.001683	.000016	....	....	
13,250	53,000	.001700	.000017	....	....	
13,500	54,000	.001717	.000017	....	....	
13,750	55,000	.001733	.000016	.000117	.000050	
14,000	56,000	.001850	.000117	....	....	
14,250	57,000	.001867	.000017	....	....	
14,500	58,000	.001917	.000050	....	....	
14,750	59,000	.001933	.000016	....	....	Elastic limit.
15,000	60,000	.002017	.000084	.000183	.000066	
15,250	61,000	.002217	.000200	....	....	
15,500	62,000	.003533	.001316	....	....	
15,750	63,000	.004200	.000667	....	....	
16,000	64,000	.005283	.001083	....	....	
16,250	65,000	.006167	.000884	.003900	.003717	
16,500	66,000	.006900	.000733	....	....	
16,750	67,000	.007600	.000700	....	....	
17,000	68,000	.009033	.001433	....	....	
17,250	69,000	.009583	.000550	....	....	
17,500	70,000	.010667	.001084	.008017	.004117	
17,750	71,000	.011250	.000583	....	....	
18,000	72,000	.012167	.000917	....	....	
18,250	73,000	.013100	.000933	....	....	
18,500	74,000	.014117	.001017	....	....	
18,750	75,000	.015233	.001116	.012200	....	
19,000	76,000	.016067	.000834	....	....	
19,250	77,000	.016933	.000866	....	....	
19,500	78,000	.017850	.000917	....	....	
19,750	79,000	.018933	.001083	....	....	
20,000	80,000	.020683	.001750	.017367	....	Micrometer removed.
20,500	82,000	.0225	.001817	....	....	
21,000	84,000	.0250	.0025	....	....	
21,500	86,000	.0275	.0025	....	....	
22,000	88,000	.0308	.0033	....	....	
22,500	90,000	.0350	.0042	....	....	
23,000	92,000	.0392	.0042	....	....	
23,500	94,000	.0425	.0033	....	....	

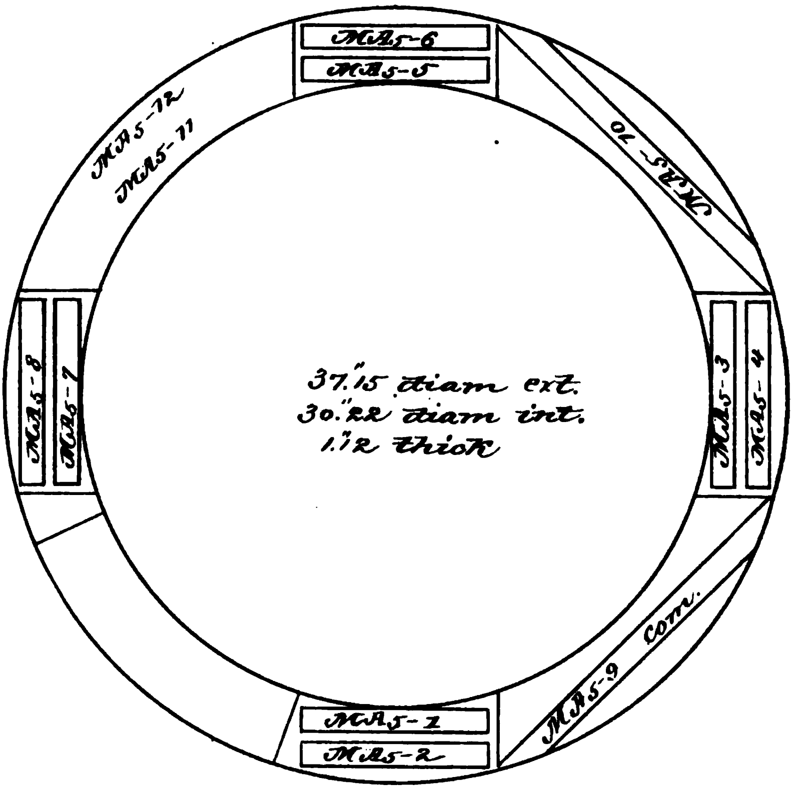
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
24, 000	96, 000	.0483	.0058	....	....	
24, 500	98, 000	.0550	.0067	....	....	
25, 000	100, 000	.0675	.0125	....	....	
25, 500	102, 000	.0833	.0158	....	....	
26, 000	104, 000	.1492	.0659	....	....	Ultimate strength.
21, 300	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	104, 000
Elastic limit per square inch of original section	do...	59, 000
Elongation per inch after rupture	inch..	0. 17
Elongation per inch under strain at elastic limit	do...	.001983
Reduction in diameter at point of rupture	do...	.164
Reduction in area after rupture, per centum of original section		49. 6
Position of rupture		⅛" from middle of stem.
Character of broken surface		silky, interspersed with minute granular spots.
Elongation of inch sections		".11, ".13 (".38 fractured section), ".18, ".13, ".09.

Hoop A5
12 inch Mortar

Rolled



S Ex 35 49 1

No. 94.

Tension test.

Marks on bar, M. A $_5$—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000150	.000150	0.	....	
2,500	10,000	.000333	.000183	0.	....	
8,750	15,000	.000467	.000134	0.	....	
5,000	20,000	.000650	.000183	0.	....	
6,250	25,000	.000783	.000133	0.	....	
7,500	80,000	.000800	.000017	0.	....	
8,750	35,000	.001083	.000283	0.	....	
10,000	40,000	.001233	.000150	0.	....	
11,250	45,000	.001400	.000167	0.	....	
12,500	50,000	.001550	.000150	0.	....	
12,750	51,000	.001600	.000050	....	....	
13,000	52,000	.001633	.000033	....	....	
18,250	53,000	.001650	.000017	....	....	
13,500	54,000	.001717	.000067	....	....	
18,750	55,000	.001750	.000033	.000033	.000033	
14,000	56,000	.001783	.000033	....	....	
14,250	57,000	.001816	.000033	....	....	
14,500	58,000	.001833	.000017	....	....	
14,750	59,000	.001867	.000034	....	....	
15,000	60,000	.001917	.000050	.000067	.000034	
15,250	61,000	.001966	.000049	....	....	
15,500	62,000	.002000	.000034	....	....	
15,750	63,000	.002033	.000033	....	....	
16,000	64,000	.002067	.000034	....	....	
16,250	65,000	.002117	.000050	.000100	.000033	
16,500	66,000	.002150	.000033	....	....	Elastic limit.
16,750	67,000	.002233	.000083	....	....	
17,000	68,000	.002316	.000083	....	....	
17,250	69,000	.002483	.000167	....	....	
17,500	70,000	.002983	.000500	.000767	.000667	
17,750	71,000	.003484	.000501	....	....	
18,000	72,000	.004450	.000966	....	....	
18,250	73,000	.005017	.000567	....	....	
18,500	74,000	.006467	.001450	....	....	
18,750	75,000	.007150	.000683	.004550	.003783	
19,000	76,000	.008150	.001000	....	....	
19,500	78,000	.010183	.002033	....	....	
20,000	80,000	.011800	.001617	.008817	.004267	
20,500	82,000	.013433	.001633	....	....	
21,000	84,000	.015500	.002067	....	....	
21,500	86,000	.017317	.001817	....	....	
22,000	88,000	.019800	.002483	....	....	
22,500	90,000	.022117	.002317	.019683	.010866	Micrometer removed.
28,000	92,000	.026666	.004549	....	....	
28,500	94,000	.028333	.001667	....	....	
24,000	96,000	.031667	.003334	....	....	
24,500	98,000	.035000	.003333	....	....	
25,000	100,000	.038333	.003333	....	....	
25,500	102,000	.043333	.005000	....	....	
26,000	104,000	.048333	.005000	....	....	
26,500	106,000	.053333	.005000	....	....	
27,000	108,000	.061667	.008334	....	....	
27,500	110,000	.078333	.016666	....	....	
27,750	111,000	....	....	....	....	Ultimate strength.
28,600	....	....	....	....	....	Load at time of rupture.

While sustaining the maximum load, the elongation slowly increased ″.017. The load then began to fall off, which continued till rupture took place.

General summary.

Tensile strength per square inch of original section	pounds	111, 000
Elastic limit per square inch of original section	do	66, 000
Elongation per inch after rupture	inch	0. 112
Elongation per inch under strain at elastic limit	do	.002150
Reduction in diameter at point of rupture	do	.164
Reduction in area after rupture, per centum of original section		49. 6
Position of rupture		″.9 from neck.
Character of broken surface		granular, 60 per centum; dull, smoky center, 40 per centum.

No. 93.

Tension test.

Marks on bar, M A_5 —2.
Length, 6″.00.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	2, 000	0.	....	....	....	Initial load.
2, 500	10, 000	.000167	.000167	0.	0.	
5, 000	20, 000	.000416	.000249	0.	0.	
7, 500	30, 000	.000833	.000417	0.	0.	
10, 000	40, 000	.001083	.000250	0.	0.	
12, 500	50, 000	.001500	.000417	0.	0.	
15, 000	60, 000	.001833	.000333	0.	0.	
15, 500	62, 000	.001917	.000084	0.	0.	
16, 000	64, 000	.002000	.000083	0.	0.	
16, 500	66, 000	.002166	.000166	0.	0.	Elastic limit.
17, 000	68, 000	.002833	.000667	.000667	.000667	
17, 500	70, 000	.004500	.001667	.002166	.001499	
18, 000	72, 000	.006250	.001750	.003833	.001667	
18, 500	74, 000	.007550	.001500	.005167	.001334	
19, 000	76, 000	.009167	.001417	.006500	.001433	
19, 500	78, 000	.011083	.001916	.008166	.001666	
20, 000	80, 000	.012500	.001417	.009750	.001584	
20, 500	82, 000	.014433	.001933	.011500	.001750	
21, 000	84, 000	.016250	.001817	.013083	.001583	
22, 000	88, 000	.020667	.004417	.017500	.004417	
23, 000	92, 000	.025666	.004999	.022167	.004667	
24, 000	96, 000	.031667	.006001	.027833	.005666	
25, 000	100, 000	.039000	.007333	.034917	.007084	
26, 000	104, 000	.050000	.011000	.045667	.010750	
27, 000	108, 000	....	....	....	....	
27, 950	111, 800	....	....	....	....	Ultimate strength.
24, 200	....	....	....	....	....	Load at time of rupture.

General summary.

Hardness		24. 84
Tensile strength per square inch of original section	pounds	111, 800
Elastic limit per square inch of original section	do	66, 000
Elongation per inch after rupture	inch	0. 16
Elongation per inch under strain at elastic limit	do	.002166
Reduction in diameter at point of rupture	do	.114
Reduction in area after rupture, per centum of original section	do	36. 4
Position of rupture		1″.2 from neck.

Character of broken surface, granular, radiating from a dull smoky colored spot ″.18 diameter at the center of the bar.

No. 97.

Tension test.

Marks on bar, M A_5—3.
Length, 3″.00.
Diameter, ″.564.
Sectional area, .25 square inches.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000066	.000066	0.	....	
2,500	10,000	.000266	.000266	0.	....	
3,750	15,000	.000400	.000134	0.	....	
5,000	20,000	.000533	.000133	0.	....	
6,250	25,000	.000700	.000167	0.	....	
7,500	30,000	.000833	.000133	0.	....	
8,750	35,000	.001033	.000200	0.	....	
10,000	40,000	.001200	.000167	0.	....	
11,250	45,000	.001367	.000167	0.	....	
12,500	50,000	.001500	.000133	0.	....	
12,750	51,000	.001567	.000067	....	....	
13,000	52,000	.001633	.000066	....	....	
13,250	53,000	.001700	.000067	....	....	
13,500	54,000	.001733	.000033	....	....	
13,750	55,000	.001733	0.	.000033	.000033	
14,000	56,000	.001767	.000034	....	....	
14,250	57,000	.001767	0.	....	....	
14,500	58,000	.001800	.000033	....	....	
14,750	59,000	.001867	.000067	....	....	
15,000	60,000	.001900	.000033	.000033	0.	
15,250	61,000	.001966	.000066	....	....	
15,500	62,000	.002000	.000034	....	....	
15,750	63,000	.002033	.000033	....	....	
16,000	64,000	.002067	.000034	....	....	
16,250	65,000	.002067	0.	.000033	0.	
16,500	66,000	.002100	.000033	....	....	
16,750	67,000	.002133	.000033	....	....	Elastic limit.
17,000	68,000	.002200	.000067	....	....	
17,250	69,000	.002267	.000067	....	....	
17,500	70,000	.002400	.000133	.000100	.000067	
17,750	71,000	.002500	.000100	....	....	
18,000	72,000	.002700	.000200	....	....	
18,250	73,000	.003067	.000367	....	....	
18,500	74,000	.003667	.000600	....	....	
18,750	75,000	004300	.000633	.001700	.001600	
19,000	76,000	.005100	.000800	....	....	
19,250	77,000	.005667	.000567	....	....	
19,500	78,000	.006667	.001000	....	....	
19,750	79,000	.007367	.000700	....	....	
20,000	80,000	.008167	.000800	.005167	.003467	Rested under initial load one hour.
20,500	82,000	.009767	.001600	....	....	
21,000	84,000	.011400	.001633	....	....	
21,500	86,000	.013400	.002000	....	....	
22,000	88,000	.015167	.001767	....	....	
22,500	90,000	.017000	.001833	.013300	.008133	
23,000	92,000	.018300	.001300	....	....	
23,500	94,000	.020667	.002367	....	....	
24,000	96,000	.022233	.001566	....	....	
24,500	98,000	.024500	.002267	....	....	
25,000	100,000	.027100	.002600	.022867	.009567	Micrometer removed.
25,500	102,000	.030000	.002900	....	....	
26,000	104,000	.036667	.006667	....	....	
26,500	106,000	.040000	.003333	....	....	
27,000	108,000	.043333	.003333	....	....	
27,500	110,000	.046667	.003334	....	....	
28,000	112,000	.050000	.003333	....	....	
28,500	114,000	.060000	.010000	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
29, 000	116, 000	. 070000	. 010000	....	....	
29, 500	118, 000	. 093333	. 023333	....	....	
29, 680	118, 720	. 113333	. 020000	....	....	Ultimate strength.
25, 600	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	118, 720
Elastic limit per square inch of original section	do ...	67, 000
Elongation per inch after rupture	inch..	0. 167
Elongation per inch under strain at elastic limit	do....	. 002133
Reduction in diameter at point of rupture	do....	. 124
Reduction in area after rupture, per centum of original section		39. 2
Position of rupture		1" from neck.
Character of broken surface		Granular, 80 per cent. dull, smoky; center, 20 per cent.

No. 98.

Tension test.

Marks on bar, M A_5—4.
Length, 3".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	....	....	Initial load.
1, 250	5, 000	. 000067	. 000067	....	....	
2, 500	10, 000	. 000167	. 000100	—. 000100	—. 000100	
3, 750	15, 000	. 000367	. 000200	—. 000100	0.	
5, 000	20, 000	. 000500	. 000133	—. 000100	0.	
6, 250	25, 000	. 000700	. 000200	—. 000100	0.	
7, 500	30, 000	. 000833	. 000133	—. 000067	. 000033	
8, 750	35, 000	. 001033	. 000200	0.	. 000067	
10, 000	40, 000	. 001167	. 000134	0.	0.	
11, 250	45, 000	. 001333	. 000166	. 000033	. 000033	
12, 500	50, 000	. 001533	. 000200	. 000067	. 000034	
12, 750	51, 000	. 001567	. 000034	....	....	
13, 000	52, 000	. 001600	. 000033	....	....	
13, 250	53, 000	. 001633	. 000033	....	....	
13, 500	54, 000	. 001733	. 000100	....	....	
13, 750	55, 000	. 001767	. 000034	. 000067	0.	
14, 000	56, 000	. 001800	. 000033	....	....	
14, 250	57, 000	. 001800	0.	....	....	
14, 500	58, 000	. 001867	. 000067	....	....	
14, 750	59, 000	. 001867	0.	....	....	
15, 000	60, 000	. 001933	. 000066	. 000067	0.	
15, 250	61, 000	. 001967	. 000034	....	....	
15, 500	62, 000	. 002000	. 000033	....	....	Elastic limit.
15, 750	63, 000	. 002067	. 000067	....	....	
16, 000	64, 000	. 002133	. 000066	....	....	
16, 250	65, 000	. 002233	. 000100	. 000100	. 000033	
16, 500	66, 000	. 002367	. 000134	....	....	
16, 750	67, 000	. 002567	. 000200	....	....	
17, 000	68, 000	. 002900	. 000333	....	....	
17, 250	69, 000	. 003533	. 000633	....	....	
17, 500	70, 000	. 004200	. 000667	. 001700	. 001600	
17, 750	71, 000	. 004833	. 000633	....	....	
18, 000	72, 000	. 005367	. 000534	....	....	
18, 250	73, 000	. 006067	. 000700	....	....	
18, 500	74, 000	. 007033	. 000966	....	....	
18, 750	75, 000	. 007633	. 000600	. 004867	. 003167	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
19,000	76,000	.008500	.000867	....	....	
19,250	77,000	.009067	.000567	....	....	
19,500	78,000	.010033	.000966	....	....	
19,750	79,000	.010767	.000734	....	....	
20,000	80,000	.011700	.000933	.008567	.003700	
20,500	82,000	.013333	.001633	....	....	
21,000	84,000	.015000	.001667	....	....	
21,500	86,000	.016833	.001833	....	....	
22,000	88,000	.018633	.001800	....	....	
22,500	90,000	.020433	.001800	.016833	.008266	
23,000	92,000	.022100	.001667	....	....	
23,500	94,000	.024367	.002267	....	....	
24,000	96,000	.027100	.002733	....	....	
24,500	98,000	.029500	.001600	....	....	
25,000	100,000	.032333	.002833	.027900	.011067	Micrometer removed.
25,500	102,000	.033333	.001000	....	....	
26,000	104,000	.036667	.003334	....	....	
26,500	106,000	.040000	.003333	....	....	
27,000	108,000	.046667	.006667	....	....	
27,500	110,000	.053333	.006666	....	....	
28,000	112,000	.060000	.006667	....	....	
28,500	114,000	.073333	.013333	....	....	
29,000	116,000	.103333	.030000	....	....	
29,050	116,200	.113333	.010000	....	....	Ultimate strength.
25,900	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section....................................pounds.. 116,200
Elastic limit per square inch of original section..do... 62,000
Elongation per inch after rupture..inch.. 0.178
Elongation per inch under strain at elastic limit..do... .002000
Reduction in diameter at point of rupture...do... .094
Reduction in area after rupture, per centum of original section.........................do... 30.8
Position of rupture..".35 from middle of stem.
Character of broken surface....................granular, 70 per cent.; dull smoky center, 30 per cent.

No. 95.

Tension test.

Marks on bar, M A_5—5.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000133	.000133	0.	....	
2,500	10,000	.000317	.000184	0.	....	
3,750	15,000	.000433	.000116	0.	....	
5,000	20,000	.000550	.000117	0.	....	
6,250	25,000	.000683	.000133	0.	....	
7,500	30,000	.000833	.000150	— .000016	— .000016	
8,750	35,000	.001000	.000167	— .000016	0.	
10,000	40,000	.001133	.000133	— .000033	— .000017	
11,250	45,000	.001283	.000150	— .000016	.000017	
12,500	50,000	.001466	.000183	— .000016	0.	
12,750	51,000	.001500	.000034	....	....	
13,000	52,000	.001516	.000016	....	....	
13,250	53,000	.001550	.000034	....	....	
13,500	54,000	.001583	.000033	....	....	
13,750	55,000	.001616	.000033	— .000016	0.	
14,000	56,000	.001650	.000034	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
14, 250	57, 000	.001683	.000033	....	....	
14, 500	58, 000	.001716	.000033	....	....	
14, 750	59, 000	.001733	.000017	....	....	
15, 000	60, 000	.001767	.000034	0.	.000016	
15, 250	61, 000	.001816	.000049	....	....	
15, 500	62, 000	.001850	.000034	....	....	
15, 750	63, 000	.001866	.000016	....	....	
16, 000	64, 000	.001900	.000034	....	....	
16, 250	65, 000	.001933	.000033	0.	0.	
16, 500	66, 000	.001983	.000060	....	....	
16, 750	67, 000	.002016	.000033	....	....	
17, 000	68, 000	.002050	.000034	....	....	
17, 250	69, 000	.002083	.000033	....	....	
17, 500	70, 000	.002150	.000067	.000033	.000033	
17, 750	71, 000	.002183	.000033	....	....	**Elastic limit.**
18, 000	72, 000	.002300	.000117	....	....	
18, 250	73, 000	.002417	.000117	....	....	
18, 500	74, 000	.002666	.000249	....	....	
18, 750	75, 000	.003183	.000517	....	....	
19, 000	76, 000	.003883	.000700	....	....	
19, 250	77, 000	.004467	.000584	....	....	
19, 500	78, 000	.005016	.000549	....	....	
19, 750	79, 000	.006083	.001067	....	....	
20, 000	80, 000	.006900	.000817	.003100	.003067	
20, 500	82, 000	.008667	.001767	....	....	
21, 000	84, 000	.010167	.001500	....	....	
21, 500	86, 000	.011966	.001799	....	....	
22, 000	88, 000	.013850	.001884	....	....	
22, 500	90, 000	.015533	.001683	.012000	.008900	**Micrometer removed.**
23, 000	92, 000	.016666	.001133	....	....	
23, 500	94, 000	.018333	.001667	....	....	
24, 000	96, 000	.020000	.001667	....	....	
24, 500	98, 000	.023333	.003333	....	....	
25, 000	100, 000	.026667	.003334	....	....	
25, 500	102, 000	.028333	.001666	....	....	
26, 000	104, 000	.031666	.003333	....	....	
26, 500	106, 000	.033333	.001667	....	....	
27, 000	108, 000	.036667	.003334	....	....	
27, 500	110, 000	.041666	.004999	....	....	
28, 000	112, 000	.046667	.005001	....	....	
28, 500	114, 000	.050000	.003333	....	....	
29, 000	116, 000	.060000	.010000	....	....	
29, 500	118, 000	.066666	.006666	....	....	
29, 900	119, 600	....	....	....	....	**Ultimate strength.**
26, 800	....	....	....	....	....	**Load at time of rupture.**

General summary.

Hardness		29.71
Tensile strength per square inch of original section	pounds..	119, 600
Elastic limit per square inch of original section	do...	71, 000
Elongation per inch after rupture	inch..	0.125
Elongation per inch under strain at elastic limit	do...	.002183
Reduction in diameter at point of rupture	do...	.114
Reduction in area after rupture, per centum of original section		36.4
Position of rupture		".7 from neck
Character of broken surface		granular, radiating from a small, dull spot near center of bar

No. 96.

Tension test.

Marks on bar, MA_5—6.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000100	.000100	0.	....	
2,500	10,000	.000266	.000166	0.	....	
3,750	15,000	.000433	.000167	0.	....	
5,000	20,000	.000583	.000150	0.	....	
6,250	25,000	.000766	.000183	0.	....	
7,500	30,000	.000933	.000167	.000017	.000017	
8,750	35,000	.001100	.000233	.000017	0.	
10,000	40,000	.001233	.000133	.000017	0.	
11,250	45,000	.001417	.000184	.000033	.000016	
12,500	50,000	.001567	.000150	.000050	.000017	
12,750	51,000	.001600	.000033	....	....	
13,000	52,000	.001617	.000017	....	....	
13,250	53,000	.001650	.000033	....	....	
13,500	54,000	.001667	.000017	....	....	
13,750	55,000	.001700	.000033	.000066	.000016	
14,000	56,000	.001733	.000033	....	....	
14,250	57,000	.001766	.000033	....	....	
14,500	58,000	.001800	.000034	....	....	
14,750	59,000	.001833	.000033	....	....	
15,000	60,000	.001867	.000034	.000083	.000017	
15,250	61,000	.001900	.000033	....	....	
15,500	62,000	.001933	..000033	....	....	
15,750	63,000	.001967	.000034	....	....	
16,000	64,000	.002000	.000033	....	....	
16,250	65,000	.002050	.000050	.000083	0.	
16,500	66,000	.002117	.000067	....	....	
16,750	67,000	.002150	.000033	....	....	
17,000	68,000	.002183	.000033	....	....	Elastic limit.
17,250	69,000	.002283	.000100	....	....	
17,500	70,000	.002450	.000167	.000350	.000267	
17,750	71,000	.002816	.000366	....	....	
18,000	72,000	.003267	.000451	....	....	
18,250	73,000	.003767	.000500	....	....	
18,500	74,000	.004216	.000449	....	....	
18,750	75,000	.004966	.000750	.002433	.002083	
19.000	76,000	.005883	.000917	....	....	
19,250	77,000	.006450	.000567	....	....	
19,500	78,000	.007100	.000650	....	....	
19,750	79,000	.007783	.000683	....	....	
20,000	80.000	.008650	.000867	.005766	.003333	
20,500	82,000	.010183	.001533	....	....	
21,000	84,000	.011983	.001800	....	....	
21,500	86,000	.013600	.001617	....	....	
22,000	88,000	.015433	.001833	....	....	
22,500	90,000	.017283	.001850	.013750	.007984	Micrometer removed.
23,000	92,000	.017500	.000217	....	....	
23,500	94,000	.018333	.000833	....	....	
24,000	96,000	.020000	.001667	....	....	
24,500	98,000	.023333	.003333	....	....	
25,000	100,000	.026667	.003334	....	....	
25,500	102,000	.030000	.003333	....	....	
26,000	104,000	.033333	.003333	....	....	
26,500	106,000	.036666	.003333	....	....	
27,060	108,000	.038333	.001667	....	....	
27,500	110,000	.043333	.005000	....	....	
28,000	112,000	.048333	.005000	....	....	
28,500	114,000	.055000	.006667	....	....	

Applied loads.		Elongation per inch.	Successive elongation par inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
29, 000	116, 000	.065000	.010000	....	....	
29, 500	118, 000	.080000	.015000	....	....	
29, 850	119, 400	.103333	.023333	....	....	Ultimate strength.
27, 100	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	119, 400
Elastic limit per square inch of original section	do...	68, 000
Elongation per inch after rupture	inch..	.127
Elongation per inch under strain at elastic limit	do...	.002183
Reduction in diameter at point of rupture	do...	.094
Reduction in area after rupture, per centum of original section		30. 8
Position of rupture		1″ from neck
Character of broken surface		granular, 80 per cent.; dull, smoky center, 20 per cent.

No. 99.

Tension test.

Marks on bar, M. A_5—7.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	....	....	Initial load.
1, 250	5, 000	.000100	.000100	0.	....	
2, 500	10, 000	.000267	.000167	0.	....	
3, 750	15, 000	.000400	.000133	0.	....	
5, 000	20, 000	.000533	.000133	0.	....	
6, 250	25, 000	.000700	.000167	0.	....	
7, 500	30, 000	.000800	.000100	0.	....	
8, 750	35, 000	.000967	.000167	0.	....	
10, 000	40, 000	.001133	.000166	0.	....	
11, 250	45, 000	.001300	.000167	0.	....	
12, 500	50, 000	.001433	.000133	0.	....	
12, 750	51, 000	.001467	.000034	0.	....	
13, 000	52, 000	.001500	.000033	....	....	
13, 250	53, 000	.001533	.000033	....	....	
13, 500	54, 000	.001567	.000034	....	....	
13, 750	55, 000	.001600	.000033	—.000033	—.000033	
14, 000	56, 000	.001667	.000067	....	....	
14, 250	57, 000	.001667	0.	....	....	
14, 500	58, 000	.001700	.000033	....	....	
14, 750	59, 000	.001767	.000067	....	....	
15, 000	60, 000	.001767	0.	0.	.000033	
15, 250	61, 000	.001833	.000066	....	....	
15, 500	62, 000	.001867	.000034	....	....	
15, 750	63, 000	.001900	.000033	....	....	
16, 000	64, 000	.002000	.000100	....	....	
16, 250	65, 000	.002000	0.	0.	0.	
16, 500	66, 000	.002100	.000100	....	....	
16, 750	67, 000	.902100	0.	....	....	
17, 000	68, 000	.002133	.000033	....	....	Elastic limit.
17, 250	69, 000	.002267	.000134	....	....	
17, 500	70, 000	.002600	.000333	.000400	.000400	
17, 750	71, 000	.003033	.000433	....	....	
18, 000	72, 000	.003767	.000734	....	....	
18, 250	73, 000	.004767	.001000	....	....	
18, 500	74, 000	.005767	.001000	....	....	
18, 750	75, 000	.006567	.000800	.004000	.003600	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
19,000	76,000	.007367	.000800	....	....	
19,250	77,000	.008367	.001000	....	....	
19,500	78,000	.009100	.000733	....	....	
19,750	79,000	.010133	.001033	....	....	
20,000	80,000	.010933	.000800	.007933	.003933	
20,500	82,000	.012767	.001834	....	....	
21,000	84,000	.015067	.002300	....	....	
21,500	86,000	.016833	.001833	....	....	
22,000	88,000	.019067	.002234	....	....	
22,500	90,000	.021133	.002066	.017567	.009634	
23,000	92,000	.022767	.001634	....	....	
23,500	94,000	.025467	.002700	....	....	
24,000	96,000	.028433	.002966	....	....	
24,500	98,000	.031700	.003267	....	....	
25,000	100,000	.035333	.003633	.031000	.013433	Micrometer removed.
25,500	102,000	.036667	.001334	....	....	
26,000	104,000	.043333	.006666	....	....	
26,500	106,000	.050000	.006667	....	....	
27,000	108,000	.060000	.010000	....	....	
27,500	110,000	.070000	.010000	....	....	
28,000	112,000	.093333	.023333	....	....	Ultimate strength.
23,000	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section..............................pounds.. 112,000
Elastic limit per square inch of original section..............................do... 68,000
Elongation per inch after rupture..............................inch.. .18
Elongation per inch under strain at elastic limit..............................do... .002133
Reduction in diameter at point of rupture..............................do... .144
Reduction in area after rupture, per centum of original section.............................. 44.4
Position of rupture.............................. ".25 from middle of stem.
Character of broken surface..............................granular, 60 per cent.; dull, smoky center, 40 per cent.

No. 100.

Tension test.

Marks on bar, M. A_5—8.
Length, 3".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000100	.000100	0.	....	
2,500	10,000	.000267	.000167	0.	....	
3,750	15,000	.000433	.000166	0.	....	
5,000	20,000	.000567	.000134	0.	....	
6,250	25,000	.000700	.000133	0.	....	
7,500	30,000	.000867	.000167	0.	....	
8,750	35,000	.001033	.000166	0.	....	
10,000	40,000	.001133	.000100	0.	....	
11,250	45,000	.001367	.000234	0.	....	
12,500	50,000	.001500	.000133	.000033	.000033	
12,750	51,000	.001533	.000033	....	....	
13,000	52,000	.001600	.000067	....	....	
13,250	53,000	.001633	.000033	....	....	
13,500	54,000	.001667	.000034	....	....	
13,750	55,000	.001700	.000033	.000033	0.	
14,000	56,000	.001733	.000033	....	....	
14,250	57,000	.001767	.000034	....	....	
14,500	58,000	.001800	.000033	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
14, 750	59, 000	.001833	.000033	....	....	
15, 000	60, 000	.001900	.000067	.000033	0.	
15, 250	61, 000	.001933	.000033	....	....	
15, 500	62, 000	.002000	.000067	....	....	
15, 750	63, 000	.002033	.000033	....	....	
16, 000	64, 000	.002067	.000034	....	....	
16, 250	65, 000	.002100	.000033	.000100	.000067	Elastic limit.
16, 500	66, 000	.002167	.000067	....	....	
16, 750	67, 000	.002333	.000166	....	....	
17, 000	68, 000	.002467	.000134	....	....	
17, 250	69, 000	.003000	.000533	....	....	
17, 500	70, 000	.003767	.000767	.001267	.001167	
17, 750	71, 000	.004467	.000700	....	....	
18, 000	72, 000	.005400	.000933	....	....	
18, 250	73, 000	.006133	.000733	....	....	
18, 500	74, 000	.007100	.000967	....	....	
18, 750	75, 000	.007767	.000667	.005100	.003833	
19, 000	76, 000	.008633	.000866	....	....	
19, 250	77, 000	.009267	.000634	....	....	
19, 500	78, 000	.010167	.000900	....	....	
19, 750	79, 000	.011033	.000866	....	....	
20, 000	80, 000	.011933	.000900	.008767	.003667	
20, 500	82, 000	.013467	.001534	....	....	
21, 000	84, 000	.015367	.001900	....	....	
21, 500	86, 000	.017433	.002066	....	....	
22, 000	88, 000	.019433	.002000	....	....	
22, 500	90, 000	.021467	.002034	.017767	.009000	
23, 000	92, 000	.023233	.001766	....	....	
23, 500	94, 000	.025767	.002534	....	....	
24, 000	96, 000	.028933	.003166	....	....	
24, 500	98, 000	.031433	.002500	....	....	
25, 000	100, 000	.034700	.003267	.030333	.012566	Micrometer removed.
25, 500	102, 000	.036667	.001967	....	....	
26, 000	104, 000	.046667	.010000	....	....	
26, 500	106, 000	.050000	.003333	....	....	
27, 000	108, 000	.056667	.006667	....	....	
27, 500	110, 000	.066667	.010000	....	....	
28, 000	112, 000	.083333	.016666	....	....	
28, 300	113, 200	.093333	....	....	....	Ultimate strength.

While sustaining the maximum load the bar elongated .04, and fractured suddenly.

General summary.

Tensile strength per square inch of original section	pounds..	113, 200
Elastic limit per square inch of original section	do ...	65, 000
Elongation per inch after rupture	inch..	.133
Elongation per inch under strain at elastic limit	do...	.002100
Reduction in diameter at point of rupture	do...	.044
Reduction in area after rupture, per centum of original section		15.2
Position of rupture		".6 from neck.

Character of broken surface.........granular, radiating from a small surface crack. Two small surface cracks developed ".4 from opposite ends.

No. 313.

Compression test.

Marks on bar, $^{\text{M A 5–9}}_{\text{Com}}$.
Length, 10″.
Diameter, 1″.
Sectional area, .7854 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
785	1, 000	0.	....	....	....	Initial load.
3, 927	5, 000	.000140	.000140	0.	....	
7, 854	10, 000	.000300	.000160	0.	....	
11, 781	15, 000	.000480	.000180	0.	....	
15, 708	20, 000	.000610	.000130	.000010	.000010	
19, 635	25, 000	.000780	.000170	.000020	.000010	
23, 562	30, 000	.000950	.000170	.000030	.000010	
27, 489	35, 000	.001100	.000150	.000050	.000020	
31, 416	40, 000	.001270	.000170	.000060	.000010	
35, 343	45, 000	.001420	.000150	.000070	.0000'0	
39, 270	50, 000	.001610	.000190	.000080	.000010	
40, 055	51, 000	.001640	.000030	....	....	
40, 841	52, 000	.001680	.000040	....	....	
41, 626	53, 000	.001710	.000030	....	....	
42, 412	54, 000	.001760	.000050	....	....	
43, 197	55, 000	.001780	.000020	.000080	0.	
43, 982	56, 000	.001830	.000040	....	....	
44, 768	57, 000	.001850	.000030	....	....	
45, 553	58, 000	.001880	.000030	....	....	
46, 339	59, 000	.001920	.000040	....	....	
47, 124	60, 000	.001960	.000040	.000090	.000010	
47, 909	61, 000	.001990	.000030	....	....	
48, 695	62, 000	.002010	.000020	....	....	
49, 480	63, 000	.002060	.000050	....	....	
50, 266	64, 000	.002100	.000040	....	....	
51, 051	65, 000	.002140	.000040	.000100	.000010	Elastic limit.
51, 836	66, 000	.002200	.000060	....	....	Perceptible deflection.
52, 622	67, 000	.002270	.000070	....	....	
53, 407	68, 000	.002370	.000100	....	....	
54, 193	69, 000	.002550	.000180	....	....	
54, 978	70, 000	.003050	.000500	.000740	.000640	Micrometer removed.
56, 500	71, 940	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under the maximum load, ″.10.

Direction of middle deflection,

General summary.

Elastic limit per square inch of original section .... pounds... 65, 00
Compression per inch under strain at elastic limit... inch... .00214

No. 314.

Compression test.

Marks on bar, M A_5—10.
Length, 10″.
Diameter, 1″.05.
Sectional area, .866 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
866	1,000	0.	....	....	....	Initial load.
4,330	5,000	.000120	.000120	0.	....	
8,060	10,000	.000290	.000170	0.	....	
12,990	15,000	.000440	.000150	.000010	.000010	
17,320	20,000	.000600	.000160	.000020	.000010	
21,650	25,000	.000770	.000170	.000040	.000020	
25,980	30,000	.000960	.000190	.000050	.000010	
30,310	35,000	.001110	.000150	.000060	.000010	
34,640	40,000	.001280	.000170	.000060	0.	
38,970	45,000	.001450	.000170	.000060	0.	
43,300	50,000	.001630	.000180	.000070	.000010	
44,166	51,000	.001650	.000020	....	....	
45,032	52,000	.001680	.000030	....	....	
45,898	53,000	.001730	.000050	....	....	
46,764	54,000	.001760	.000030	....	....	
47,630	55,000	.001800	.000040	.000080	.000010	
48,496	56,000	.001830	.000030	....	....	
49,362	57,000	.001860	.000030	....	....	
50,228	58,000	.001900	.000040	....	....	
51,094	59,000	.001940	.000040	....	....	
51,960	60,000	.001980	.000040	.000090	.000010	
52,826	61,000	.002020	.000040	....	....	
53,692	62,000	.002080	.000060	....	....	
54,558	63,000	.002110	.000030	....	....	Elastic limit.
55,424	64,000	.002170	.000060	....	....	
56,290	65,000	.002300	.000130	.000240	.000150	
57,156	66,000	.002490	.000190	....	....	Perceptible deflection.
58,022	67,000	.002800	.000310	....	....	
58,888	68,000	.003380	.000580	....	....	
60,200	69,520	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under the maximum load, ″.10.

Direction of middle deflection, .

General summary.

Elastic limit per square inch of original section	pounds..	63,000
Compression per inch under strain at elastic limit	inch..	.002110
Compression per inch under 65,000 pounds per square inch	do...	.002300

No. 315.

Compression test.

Marks on bar, M A_5—11.
Length, 10″.
Diameter, 1″.019.
Sectional area, .817 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
817	1, 000	0.	....	....	....	Initial load.
4, 085	5, 000	.000110	.000110	0.	....	
8, 170	10, 000	.000250	.000140	.000010	.000010	
12, 255	15, 000	.000410	.000160	.000020	.000010	
16, 340	20, 000	.000590	.000180	.000030	.000010	
20, 425	25, 000	.000750	.000160	.000040	.000010	
24, 510	30, 000	.000910	.000160	.000040	0.	
28, 595	35, 000	.001100	.000190	.000040	0.	
32, 680	40, 000	.001260	.000160	.000050	.000010	
36, 765	45, 000	.001440	.000180	.000060	.000010	
40, 850	50, 000	.001620	.000180	.000070	.000010	
41, 667	51, 000	.001670	.000050	....	....	
42, 484	52, 000	.001700	.000030	....	....	
43, 301	53, 000	.001740	.000040	....	....	
44, 118	54, 000	.001790	.000050	....	....	
44, 935	55, 000	.001820	.000030	.000100	.000030	
45, 752	56, 000	.001870	.000050	....	....	Elastic limit.
46, 569	57, 000	.001930	.000060	....	....	
47, 386	58, 000	.002040	.000110	....	....	Perceptible deflection.
48, 203	59, 000	.003300	.001260	....	....	
49, 550	60, 650	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under the maximum load, ″.10.

Direction of middle defection,

General summary.

Elastic limit per square inch of original section	pounds..	56, 000
Compression per inch under strain at elastic limit	inch..	.001870
Compression per inch under 57,000 pounds per square inch	do....	.001930

No. 316.

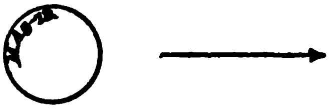
Compression test.

Marks on bar, M A_5—12.
Length, 10″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads per square inch.	Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
1,000	0.	....	....	....	Initial load.
5,000	.000110	.000110	0.	....	
10,000	.000260	.000150	.000010	.000010	
15,000	.000400	.000140	.000020	.000010	
20,000	.000550	.000150	.000030	.000010	
25,000	.000690	.000140	.000030	0.	
30,000	.000860	.000170	.000040	.000010	
35,000	.001030	.000160	.000040	0.	
40,000	.001180	.000160	.000040	0.	
45,000	.001350	.000170	.000050	.000010	
50,000	.001510	.000160	.000050	0.	
51,000	.001540	.000030	....	....	
52,000	.001570	.000030	....	....	
53,000	.001600	.000030	....	....	
54,000	.001640	.000040	....	....	
55,000	.001670	.000030	.000050	0.	
56,000	.001690	.000020	....	....	
57,000	.001740	.000050	....	....	
58,000	.001770	.000030	....	....	
59,000	.001800	.000030	....	....	
60,000	.001850	.000050	.000060	.000010	Elastic limit.
61,000	.005700	.003850	....	....	Rapid deflection.
61,600	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Middle deflection under the maximum load, ″.16.

Direction of middle deflection,

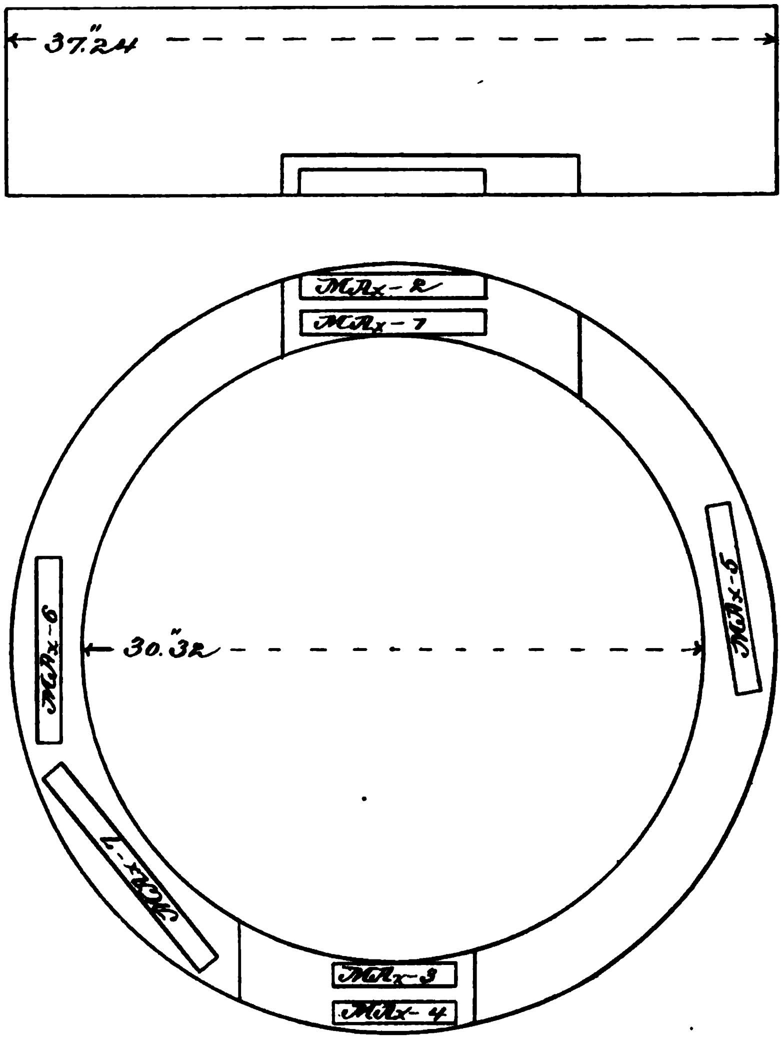


General summary.

Elastic limit per square inch of original section	pounds..	60,000
Compression per inch under strain at elastic limit	inch..	001850

Hoop Ax
12 inch Mortar

Rolled



No. 265.

Tension test.

Marks on bar, M A_x—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000117	.000117	0.	....	
2,500	10,000	.000267	.000150	0.	....	
3,750	15,000	.000383	.000116	0.	....	
5,000	20,000	.000567	.000184	0.	....	
6,250	25,000	.000717	.000150	0.	....	
7,500	30,000	.000867	.000150	0.	....	
8,750	35,000	.001000	.000133	0.	....	
10,000	40,000	.001150	.000150	0.	....	
10,250	41,000	.001167	.000017	....	....	
10,500	42,000	.001217	.000050	....	....	
10,750	43,000	.001267	.000050	....	....	
11,000	44,000	.001317	.000050	....	....	
11,250	45,000	.001367	.000050	0.	....	
11,500	46,000	.001383	.000016	....	....	
11,750	47,000	.001400	.000017	....	....	
12,000	48,000	.001417	.000017	....	....	
12,250	49,000	.001467	.000050	....	....	
12,500	50,000	.001500	.000033	0.	....	
12,750	51,000	.001500	0.	....	....	
13,000	52,000	.001567	.000067	....	....	
13,250	53,000	.001633	.000066	....	....	
13,500	54,000	.001667	.000034	....	....	
13,750	55,000	.001683	.000016	0.	....	
14,000	56,000	.001733	.000050	....	....	
14,250	57,000	.001767	.000034	....	....	
14,500	58,000	.001800	.000033	....	....	
14,750	59,000	.001833	.000033	....	....	
15,000	60,000	.001867	.000034	.000017	.000017	
15,250	61,000	.001933	.000066	....	....	
15,500	62,000	.002000	.000067	....	....	
15,750	63,000	.002033	.000033	....	....	Elastic limit.
16,000	64,000	.002150	.000117	....	....	
16,250	65,000	.002233	.000083	.000183	.000166	
16,500	66,000	.002450	.000217	....	....	
16,750	67,000	.002817	.000367	....	....	
17,000	68,000	.002900	.000083	....	....	
17,250	69,000	.003250	.000350	....	....	
17,500	70,000	.004017	.000767	.001650	.001467	Micrometer removed.
18,000	72,000	.0050	.000983	....	....	
18,500	74,000	.0067	.0017	....	....	
19,000	76,000	.0083	.0016	....	....	
19,500	78,000	.0100	.0017	....	....	
20,000	80,000	.0117	.0017	....	....	
20,500	82,000	.0133	.0016	....	....	
21,000	84,000	.0150	.0017	....	....	
21,500	86,000	.0167	.0017	....	....	
22,000	88,000	.0183	.0016	....	....	
22,500	90,000	.0200	.0017	....	....	
23,000	92,000	.0217	.0017	....	....	
23,500	94,000	.0250	.0033	....	....	
24,000	96,000	.0283	.0033	....	....	
24,500	98,000	.0317	.0034	....	....	
25,000	100,000	.0333	.0016	....	....	
25,500	102,000	.0383	.0050	....	....	
26,000	104,000	.0417	.0034	....	....	
26,500	106,000	.0450	.0033	....	....	
27,000	108,000	.0517	.0067	....	....	
27,500	110,000	.0583	.0066	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28,000	112,000	.0650	.0067	....	....	
28,500	114,000	.0867	.0217	....	....	
28,800	115,200	.1117	.0250	....	....	Ultimate strength.
26,400	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	115,200
Elastic limit per square inch of original section	do...	63,000
Elongation per inch after rupture	inch..	.13
Elongation per inch under strain at elastic limit	do...	.002033
Reduction in diameter at point of rupture	do...	.084
Reduction in area after rupture, per centum of original section	do...	27.6
Position of rupture		2".4 from neck.
Character of broken surface		granular, small dull spot near center of fractured surface.
Elongation of inch sections		".09, ".16 (".21 fractured section), ".10, ".11, ".11

No. 266.

Tension test.

Marks on bar, M. A_x — 2.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000133	.000133	0.	....	
2,000	10,000	.000267	.000134	0.	....	
3,750	15,000	.000450	.000183	0.	....	
5,000	20,000	.000600	.000150	.000017	.000017	
6,250	25,000	.000733	.000133	.000017	0.	
7,500	30,000	.000883	.000150	.000017	0.	
8,750	35,000	.001050	.000167	.000017	0.	
10,000	40,000	.001217	.000167	.000017	0.	
10,250	41,000	.001267	.000050	....	....	
10,500	42,000	.001283	.000016	....	....	
10,750	43,000	.001317	.000034	....	....	
11,000	44,060	.001333	.000016	....	....	
11,250	45,000	.001350	.000017	.000017	0.	
11,500	46,000	.001383	.000033	....	....	
11,750	47,000	.001433	.000050	....	....	
12,000	48,000	.001483	.000050	....	....	
12,250	49,000	.001517	.000034	....	....	
12,500	50,000	.001533	.000016	.000017	0.	
12,750	51,000	.001567	.000034	....	....	
13,000	52,000	.001617	.000050	....	....	
13,250	53,000	.001667	.000050	....	....	
13,500	54,000	.001700	.000033	....	....	
13,750	55,000	.001733	.000033	.000017	0.	
14,000	56,000	.001767	.000034	....	....	
14,250	57,000	.001800	.000033	....	....	
14,500	58,000	.001850	.000050	....	....	
14,750	59,000	.001883	.000033	....	....	Elastic limit.
15,000	60,000	.002000	.000117	.000100	.000083	
15,250	61,000	.002083	.000083	....	....	
15,500	62,000	.002150	.000067	....	....	
15,750	63,000	.002200	.000050	....	....	
16,000	64,000	.002367	.000167	....	....	
16,250	65,000	.002550	.000183	.000450	.000350	
16,500	66,000	.002850	.000300	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16, 750	67, 000	.003167	.000317	....	....	
17, 000	68, 000	.003683	.000516	....	....	
17, 250	69, 000	.004450	.000767	....	....	
17, 500	70, 000	.005333	.000883	.002850	.002400	Micrometer removed.
18, 000	72, 000	.0067	.001367	....	....	
18, 500	74, 000	.0083	.0016	....	....	
19, 000	76, 000	.0100	.0017	....	....	
19, 500	78, 000	.0125	.0025	....	....	
20, 000	80, 000	.0142	.0017	....	....	
20, 500	82, 000	.0158	.0016	....	....	
21, 000	84, 000	.0167	.0009	....	....	
21, 500	86, 000	.0192	.0025	....	....	
22, 000	88, 000	.0208	.0016	....	....	
22, 500	90, 000	.0233	.0025	....	....	
23, 000	92, 000	.0258	.0025	....	....	
23, 500	94, 000	.0283	.0025	....	....	
24, 000	96, 000	.0317	.0034	....	....	
24, 500	98, 000	.0333	.0016	....	....	
25, 000	100. 000	.0375	.0042	....	....	
25, 500	102, 000	.0408	.0033	....	....	
26, 000	104, 000	.0450	.0042	....	....	
26, 500	106, 000	.0500	.0050	....	....	
27, 000	108, 000	.0583	.0083	....	....	
27, 500	110, 000	.0692	.0109	....	....	
28, 000	112, 000	.0850	.0158	....	....	
28, 150	112, 600	.0900 .1083	.0233	....	....	Ultimate strength.
26, 500	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity		7. 8552
Hardness		27. 32
Tensile strength per square inch of original section	pounds..	112, 600
Elastic limit per square inch of original section	do...	59, 000
Elongation per inch after rupture	inch..	0. 123
Elongation per inch under strain at elastic limit	do...	.001833
Reduction in diameter at point of rupture	do...	.084
Reduction in area after rupture, per centum of original section		27. 6
Position of rupture		2″. 5 from neck.
Character of broken surface		granular.
Elongation of inch sections		″.10 ″.12 (″.22 fractured section) ″.12 ″.10 ″.08

No. 271.

Tension test.

Marks on bar, MA_x—3.
Length, 3″.
Diameter, ″.560.
Sectional area, .246 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
246	1, 000	0.	....	0.	....	Initial load.
1, 230	5, 000	.000167	.000167	0.	....	
2, 460	10, 000	.000333	.000166	0.	....	
3, 690	15, 000	.000467	.000134	0.	....	
4, 920	20, 000	.000600	.000133	0.	....	
6, 150	25, 000	.000767	.000167	0.	....	
7, 380	30, 000	.000833	.000066	0.	....	
8, 610	35, 000	.001033	.000200	0.	....	
9, 840	40, 000	.001167	.000134	0.	....	
10, 086	41, 000	.001167	0.	....	....	
10, 332	42, 000	.001200	.000033	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10, 578	43, 000	. 001233	. 000033	....	....	
10, 824	44, 000	. 001300	. 000067	....	....	
11, 070	45, 000	. 001333	. 000033	0.	....	
11, 316	46, 000	. 001433	. 000100	....	....	
11, 562	47, 000	. 001433	0.	....	....	
11, 808	48, 000	. 001467	. 000034	....	....	
12, 054	49, 000	. 001467	0.	....	....	
12, 300	50, 000	. 001500	. 000033	0.	....	
12, 546	51, 000	. 001500	0.	....	....	
12, 792	52, 000	. 001533	. 000033	....	....	
13, 038	53, 000	. 001600	. 000067	....	....	
13, 284	54, 000	. 001633	. 000033	0.	....	
13, 530	55, 000	. 001667	. 000034	....	....	
13, 776	56, 000	. 001767	. 000100	....	....	
14, 022	57, 000	. 001800	. 000033	....	....	
14, 268	58, 000	. 001800	0.	....	....	
14, 514	59, 000	. 001833	. 000033	....	....	
14, 760	60, 000	. 001933	. 000100	. 000100	. 000100	
15, 006	61, 000	. 002067	. 000134	....	....	
15, 252	62, 000	. 002133	. 000066	....	....	
15, 498	63, 000	. 002200	. 000067	....	....	Elastic limit.
15, 744	64, 000	. 002500	. 000300	....	....	
15, 990	65, 000	. 002867	. 000367	. 000833	. 000733	
16, 236	66, 000	. 003467	. 000600	....	....	
16, 482	67, 000	. 003833	. 000366	....	....	
16, 728	68, 000	. 004533	. 000700	....	....	
16, 974	69, 000	. 005333	. 000800	....	....	
17, 220	70, 000	. 006267	. 000934	. 003800	. 002967	Micrometer removed.
17, 712	72, 000	. 0067	. 000433	....	....	
18, 204	74, 000	. 0083	. 0016	....	....	
18, 696	76, 000	. 0133	. 0050	....	....	
19, 188	78, 000	. 0150	. 0017	....	....	
19, 680	80, 000	. 0150	0.	....	....	
20, 172	82, 000	. 0167	. 0017	....	....	
20, 664	84, 000	. 0183	. 0016	....	....	
21, 156	86, 000	. 0200	. 0017	....	....	
21, 648	88, 000	. 0200	0.	....	....	
22, 140	90, 000	. 0233	. 0033	....	....	
22, 632	92, 000	. 0250	. 0017	....	....	
23, 124	94, 000	. 0283	. 0033	....	....	
23, 616	96, 000	. 0300	. 0017	....	....	
24, 108	98, 000	. 0350	. 0050	....	....	
24, 600	100, 000	. 0367	. 0017	....	....	
25, 092	102, 000	. 0417	. 0050	....	....	
25, 584	104, 000	. 0467	. 0050	....	....	
26, 076	106, 000	. 0533	. 0066	....	....	
26, 568	108, 000	. 0633	. 0100	....	....	
27, 060	110, 000	. 0783	. 0150	....	....	
27, 552	112, 000	. 1883	. 0600	....	....	Ultimate strength.
25, 100	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds	112, 000
Elastic limit per square inch of original section	do	63, 000
Elongation per inch after rupture	inch	0. 183
Elongation per inch under strain at elastic limit	do	. 002200
Reduction in diameter at point of rupture	do	0. 10
Reduction in area after rupture, per centum of original section		32. 5
Position of rupture		⅛″ from middle of stem.
Character of broken surface		granular; small dull spot at center.
Elongation of inch sections		″.13 (″.30 fractured section) ″.12

No. 272.

Tension test.

Marks on bar, M A_x—4.
Length, 3″.
Diameter, ″.560.
Sectional area, .246 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
246	1, 000	0.		0.		Initial load.
1, 230	5, 000	.000033	.000033	0.		
2, 460	10, 000	.000067	.000034	0.		
3, 690	15, 000	.000133	.000066	0.		
4, 920	20, 000	.000400	.000267	0.		
6, 150	25, 000	.000667	.000267	0.		
7, 380	30, 000	.000733	.000066	0.		
8, 610	35, 000	.001000	.000267	0.		
9, 840	40, 000	.001067	.000067	0.		
10, 086	41, 000	.001067	0.			
10, 332	42, 000	.001067	0.			
10, 578	43, 000	.001100	.000033			
10, 824	44, 000	.001133	.000033			
11, 070	45, 000	.001267	.000134	0.		
11, 316	46, 000	.001333	.000066			
11, 562	47, 000	.001367	.000034			
11, 808	48, 000	.001400	.000034			
12, 054	49, 000	.001400	0.			
12, 300	50, 000	.001433	.000033	0.		
12, 546	51, 000	.001433	0.			
12, 792	52, 000	.001467	.000034			
13, 038	53, 000	.001500	.000033			
13, 284	54, 000	.001533	.000033			
13, 530	55, 000	.001600	.000067	.000000	.000000	
13, 776	56, 000	.001667	.000067			
14, 022	57, 000	.001733	.000066			
14, 268	58, 000	.001800	.000067			
14, 514	59, 000	.001833	.000033			
14, 760	60, 000	.001867	.000034	.000067	.000067	Elastic limit.
15, 006	61, 000	.002000	.000133			
15, 252	62, 000	.002100	.000100			
15, 498	63, 000	.002233	.000133			
15, 744	64, 000	.002400	.000167			
15, 990	65, 000	.001767	.000367	.000733	.000666	
16, 236	66, 000	.003400	.000633			
16, 482	67, 000	.003800	.000400			
16, 728	68, 000	.004700	.000900			
16, 974	69, 000	.005367	.000667			
17, 220	70, 000	.006333	.000966	.003733	.003000	Micrometer removed.
17, 712	72, 000	.0083	.001967			
18, 204	74, 000	.0100	.0017			
18, 696	76, 000	.0133	.0033			
19, 188	78, 000	.0167	.0034			
19, 680	80, 000	.0183	.0016			
20, 172	82, 000	.0183	0.			
20, 664	84, 000	.0200	.0017			
21, 156	86, 000	.0217	.0017			
21, 648	88, 000	.0233	.0016			
22, 140	90, 000	.0267	.0034			
22, 632	92, 000	.0300	.0033			
23, 124	94, 000	.0317	.0017			
23, 616	96, 000	.0333	.0016			
24, 108	98, 000	.0367	.0034			
24, 600	100, 000	.0400	.0033			
25, 092	102, 000	.0450	.0050			
25, 584	104, 000	.0500	.0050			
26, 076	106, 000	.0533	.0033			

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
26, 568	108, 000	.0667	.0134	....	....	
27, 060	110, 000	.0767	.0100	....	....	
27, 520	111, 870	.1167	.0400	....	....	Ultimate strength.
25, 700	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity	7. 8551
Hardness	25. 43
Tensile strength per square inch of original section ... pounds	111, 870
Elastic limit per square inch of original section ... do	60, 000
Elongation per inch after rupture ... inch	0. 157
Elongation per inch under strain at elastic limit ... do	.001867
Reduction in diameter at point of rupture ... do	.080
Reduction in area after rupture, per centum of original section	26. 4
Position of rupture	⅜" from middle of stem.
Character of broken surface	granular.
Elongation of inch sections	".16 (".20 fractured section), ".11

No. 310.

Tension test.

Marks on bar, $^{\text{M}}{}^{\text{Ax}}_{\text{5}}$

Length, 6".

Diameter, ".564.

Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000117	.000117	0.	....	
2, 500	10, 000	.000233	.000116	0.	....	
3, 750	15, 000	.000383	.000150	0.	....	
5, 000	20, 000	.000550	.000167	0.	....	
6, 250	25, 000	.000700	.000150	0.	....	
7, 500	30, 000	.000867	.000167	0.	....	
8, 750	35, 000	.001033	.000166	0.	....	
10, 000	40, 000	.001200	.000167	0.	....	
10, 250	41, 000	.001217	.000017	....	....	
10, 500	42, 000	.001250	.000033	....	....	
10, 750	43, 000	.001283	.000033	....	....	
11, 000	44, 000	.001317	.000034	....	....	
11, 250	45, 000	.001350	.000033	0.	....	
11, 500	46, 000	.001383	.000033	....	....	
11, 750	47, 000	.001400	.000017	....	....	
12, 000	48, 000	.001433	.000033	....	....	
12, 250	49, 000	.001467	.000034	....	....	
12, 500	50, 000	.001533	.000066	0.	....	
12, 750	51, 000	.001567	.000034	....	....	
13, 000	52, 000	.001600	.000033	....	....	
13, 250	53, 000	.001633	.000033	....	....	
13, 500	54, 000	.001667	.000034	....	....	
13, 750	55, 000	.001700	.000033	0.	....	
14, 000	56, 000	.001733	.000033	....	....	
14, 250	57, 000	.001767	.000034	....	....	
14, 500	58, 000	.001800	.000033	....	....	
14, 750	59, 000	.001833	.000033	....	....	
15, 000	60, 000	.001867	.000034	0.	....	
15, 250	61, 000	.001933	.000066	....	....	
15, 500	62, 000	.001983	.000050	....	....	
15, 750	63, 000	.002050	.000067	....	....	
16, 000	64, 000	.002117	.000067	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16, 250	65, 000	.002183	.000066	.000117	.000117	Elastic limit.
16, 500	66, 000	.002350	.000167	....	....	
16, 750	67, 000	.002467	.000117	....	....	
17, 000	68, 000	.002733	.000266	....	....	
17, 250	69, 000	.003133	.000400	....	....	
17, 500	70, 000	.004017	.000884	.001583	.001466	
18, 000	72, 000	.005300	.001283	....	....	
18, 500	74, 000	.007033	.001733	....	....	
19, 000	76, 000	.008967	.001934	....	....	
19, 500	78, 000	.010667	.001700	....	....	
20, 000	80, 000	.012167	.001500	....	....	
20, 500	82, 000	.013367	.001200	....	....	
21, 000	84, 000	.015783	.002416	....	....	
21, 500	86, 000	.017450	.001667	....	....	
22, 000	88, 000	.019800	.002350	....	....	
22, 500	90, 000	.021500	.001700	....	....	
23, 000	92, 000	.023167	.001667	....	....	
23, 500	94, 000	.026133	.002966	....	....	Micrometer removed.
24, 000	96, 000	.0283	.002167	....	....	
24, 500	98, 000	.0308	.0025	....	....	
25, 000	100, 000	.0333	.0025	....	....	
25, 500	102, 000	.0383	.0050	....	....	
26, 000	104, 000	.0433	.0050	....	....	
26, 500	106, 000	.0483	.0050	....	....	
27, 000	108, 000	.0533	.0050	....	....	
27, 500	110, 000	.0650	.0017	....	....	
28, 000	112, 000	.0900	.0250	....	....	
28, 020	112, 080	.1067	.0167	....	....	Ultimate strength.
26, 100	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	112, 080
Elastic limit per square inch of original section	do ..	65, 000
Elongation per inch after rupture	inch..	0. 1267
Elongation per inch under strain at elastic limit	do...	.002183
Reduction in diameter at point of rupture	do...	.074
Reduction in area after rupture, per centum of original section		24. 4

Position of rupture .... ¾″ from middle of stem.
Character of broken surface .... granular, radiating from a small dull spot at the circumference.
Elongation of inch sections .... ″.09, ″.09, ″.11 (″.22 fractured section), ″.14, ″.09.

No. 311.

Tension test.

Marks on bar, $^{\mathrm{M.A1.}}_{6}$.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000083	.000083	0.	....	
2, 500	10, 000	.000217	.000134	0.	....	
3, 750	15, 000	.000367	.000150	0.	....	
5, 000	20, 000	.000533	.000166	0.	....	
6, 250	25, 000	.000700	.000167	0.	....	
7, 500	30, 000	.000850	.000150	0.	....	
8, 750	35, 000	.001083	.000183	0.	....	
10, 000	40, 000	.001183	.000150	0.	....	
10, 250	41, 000	.001200	.000017	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds	*Pounds.*	*Inch.*	*Inch.*	*inch.*	*inch.*	
10, 500	42, 000	. 001233	. 000033	....	....	
10, 750	43, 000	. 001283	. 000050	....	....	
11, 000	44, 000	. 001317	. 000034	....	....	
11, 250	45, 000	. 001350	. 000033	0.	....	
11, 500	46, 000	. 001383	. 000033	....	....	
11, 750	47, 000	. 001400	. 000017	....	....	
12, 000	48, 000	. 001433	. 000033	....	....	
12, 250	49, 000	. 001467	. 000034	....	....	
12, 500	50, 000	. 001500	. 000033	. 000017	. 000017	
12, 750	51, 000	. 001567	. 000067	....	....	
13, 000	52, 000	. 001583	. 000016	....	....	
13, 250	53, 000	. 001617	. 000034	....	....	
13, 500	54, 000	. 001667	. 000050	....	....	
13, 750	55, 000	. 001700	. 000033	. 000033	. 000016	
14, 000	56, 000	. 001733	. 000033	....	....	
14, 250	57, 000	. 001767	. 000034	....	....	
14, 500	58, 000	. 001800	. 000033	....	....	
14, 750	59, 000	. 001833	. 000033	....	....	
15, 000	60, 000	. 001933	. 000100	. 000067	. 000034	
15, 250	61, 000	. 001983	. 000050	....	....	
15, 500	62, 000	. 002067	. 000084	....	....	
15, 750	63, 000	. 002150	. 000083	....	....	Elastic limit.
16, 000	64, 000	. 002317	. 000167	....	....	
16, 250	65, 000	. 002483	. 000166	. 000400	. 000333	
16, 500	66, 000	. 002817	. 000334	....	....	
16, 750	67, 000	. 003150	. 000333	....	....	
17, 000	68, 000	. 003667	. 000517	....	....	
17, 250	69, 000	. 004400	. 000733	....	....	
17, 500	70, 000	. 005350	. 000950	. 002833	. 002433	
18, 000	72, 000	. 006617	. 001267	....	....	
18, 500	74, 000	. 008300	. 001683	....	....	
19, 000	76, 000	. 009733	. 001433	....	....	
19, 500	78, 000	. 011700	. 001967	....	....	
20, 000	80, 000	. 013733	. 002133	....	....	
20, 500	82, 000	. 015383	. 001650	....	....	
21, 000	84, 000	. 016533	. 001150	....	....	
21, 500	86, 000	. 018700	. 002167	....	....	
22, 000	88, 000	. 020783	. 002083	....	....	
22, 500	90, 000	. 022867	. 002084	....	....	
23, 000	92, 000	. 025367	. 002500	....	....	
23, 500	94, 000	. 027700	. 002333	....	....	
24, 000	96, 000	. 030500	. 002800	....	....	
24, 500	98, 000	. 033583	. 003083	....	....	
25, 000	100, 000	. 037783	. 004200	....	....	Micrometer removed.
25, 500	102, 000	. 0417	. 003967	....	....	
26, 000	104, 000	. 0467	. 0050	....	....	
26, 500	106, 000	. 0517	. 0050	....	....	
27, 000	108, 000	. 0633	. 0116	....	....	
27, 500	110, 000	. 0783	. 0150	....	....	
27, 700	110, 800	. 1050	. 0267	....	....	Ultimate strength.
26, 500	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section . ...pounds.. 110, 800
Elastic limit per square inch of original section ....do.... 63, 000
Elongation per inch after rupture ....inch.. 0. 1267
Elongation per inch under strain at elastic limit.......... ....do... . 002150
Reduction in diameter at point of rupture .. ..do.. . 084
Reduction in area after rupture, per centum of original section 27. 6
Position of rupture ....1".10 from middle of stem.
Character of broken surface ....granular, radiating from a dull spot at circumference.
Elongation of inch sections ....".09, ".12, ".10 (".21 fractured section), ".16, ".08.

No. 374.

Compression test.

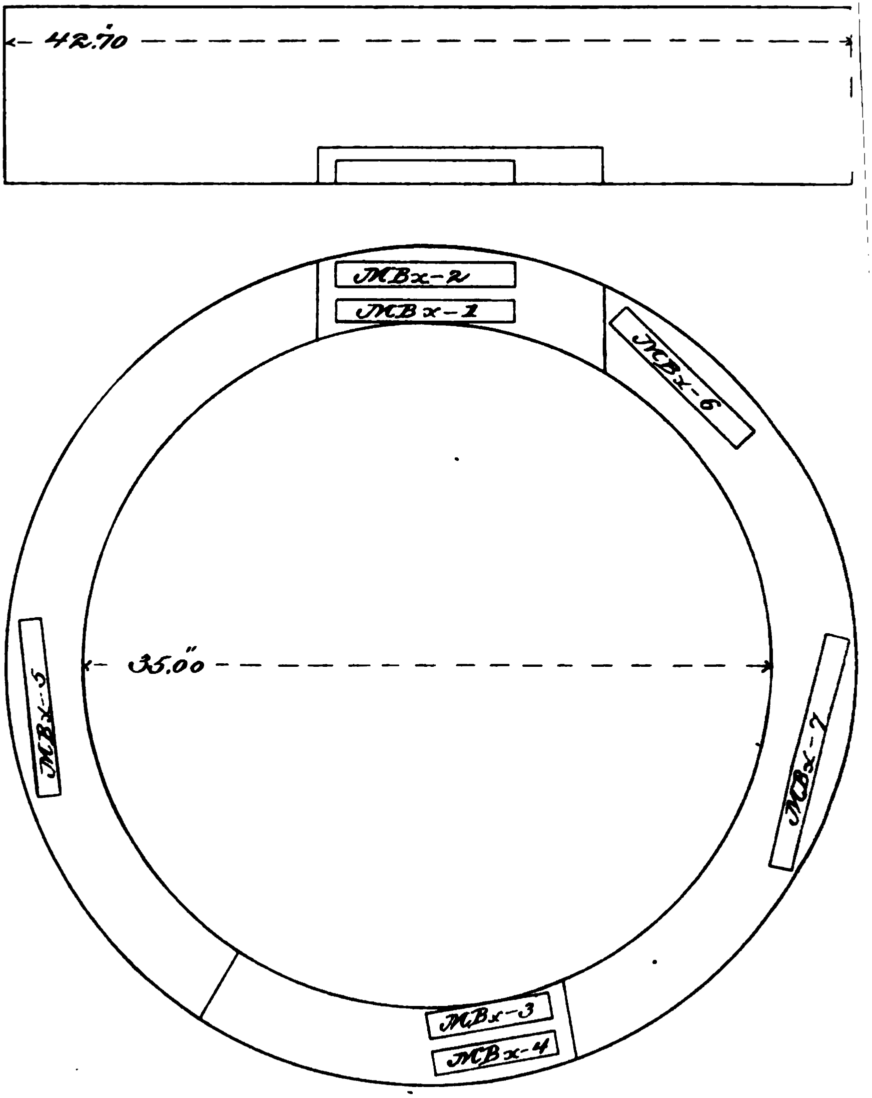
Marks on bar, $\text{M.}\,\overset{\text{Al.}}{7}$
Length, 11″.97.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
5,000	5,000	.000150	.000150	0.	....	
10,000	10,000	.000290	.000140	0.	....	
15,000	15,000	.000450	.000160	0.	....	
20,000	20,000	.000610	.000160	0.	....	
25,000	25,000	.000770	.000160	0.	....	
30,000	30,000	.000930	.000160	0.	....	
35,000	35,000	.001100	.000170	0.	....	
40,000	40,000	.001260	.000160	0.	....	
41,000	41,000	.001300	.000040	....	....	
42,000	42,000	.001330	.000030	....	....	
43,000	43,000	.001370	.000040	....	....	
44,000	44,000	.001400	.000030	....	....	
45,000	45,000	.001440	.000040	.000010	.000010	
46,000	46,000	.001470	.000030	....	....	
47,000	47,000	.001500	.000030	....	....	
48,000	48,000	.001530	.000030	....	....	
49,000	49,000	.001570	.000040	....	....	
50,000	50,000	.001600	.000030	.000020	.000010	
41,000	51,000	.001630	.000030	....	....	
52,000	52,000	.001670	.000040	....	....	
53,000	53,000	.001700	.000030	....	....	
54,000	54,000	.001730	.000030	....	....	
55,000	55,000	.001770	.000040	.000030	.000010	
56,000	56,000	.001820	.000050	....	....	
57,000	57,000	.001850	.000030	....	....	
58,000	58,000	.001870	.000020	....	....	
59,000	59,000	.001930	.000060	....	....	
60,000	60,000	.001990	.000060	.000090	.000060	Perceptible deflection.
61,000	61,000	.002070	.000080	....	....	
62,000	62,000	.002180	.000110	....	....	
63,000	63,000	.002300	.000120	....	....	
64,000	64,000	.002460	.000160	....	....	
65,000	65,000	.002720	.000260	.000570	.000480	
66,000	66,000	.002980	.000260	....	....	
67,000	67,000	.003500	.000520	....	....	
68,000	68,000	.004480	.000980	....	....	Micrometer removed; rapid deflection going on.
69,400	69,400	....	....	....	....	Middle deflection .08.
70,300	70,300	....	....	....	....	Middle deflection .10.
70,600	70,600	....	....	....	....	Middle deflection .14. Ultimate strength.

Failed by triple flexure.

Hoop Bx
12 inch Mortar

Rolled



S Ex 35 49 1

No. 267.

Tension test.

Marks on bar, M.B$_x$—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	. 000050	. 000050	—. 000017	—. 000017	
2, 500	10, 000	. 000167	. 000117	—. 000017	0.	
3, 750	15, 000	. 000333	. 000166	—. 000033	—. 000016	
5, 000	20, 000	. 000483	. 000150	—. 000033	0.	
6, 250	25, 000	. 000633	. 000150	—. 000050	—. 000017	
7, 500	30, 000	. 000817	. 000184	—. 000050	0.	
8, 750	35, 000	. 000950	. 000133	—. 000050	0.	
10, 000	40, 000	. 001100	. 000150	—. 000050	0.	
10, 250	41, 000	. 001117	. 000017	....	....	
10, 500	42, 000	. 001150	. 000033	....	....	
10, 750	43, 000	. 001167	. 000017	....	....	
11, 000	44, 000	. 001183	. 000016	....	....	
11, 250	45, 000	. 001217	. 000034	—. 000067	—. 000017	
11, 500	46, 000	. 001267	. 000050	....	....	
11, 750	47, 000	. 001300	. 000033	....	....	
12, 000	48, 000	. 001350	. 000050	....	....	
12, 250	49, 000	. 001383	. 000033	....	....	
12, 500	50, 000	. 001417	. 000034	—. 000067	0.	
12, 750	51, 000	. 001433	. 000016	....	....	
13, 000	52, 000	. 001500	. 000067	....	....	
13, 250	53, 000	. 001533	. 000033	....	....	
13, 500	54, 000	. 001550	. 000017	....	....	
13, 750	55, 000	. 001583	. 000033	—. 000067	0.	
14, 000	56, 000	. 001600	. 000017	....	....	
14, 250	57, 000	. 001633	. 000033	....	....	
14, 500	58, 000	. 001683	. 000050	....	....	
14, 750	59, 000	. 001700	. 000017	....	....	
15, 000	60, 000	. 001750	. 000050	—. 000067	0.	
15, 250	61, 000	. 001800	. 000050	....	....	
15, 500	62, 000	. 001833	. 000033	....	....	
15, 750	63, 000	. 001850	. 000017	....	....	
16, 000	64, 000	. 001883	. 000033	....	....	
16, 250	65, 000	. 001933	. 000050	—. 000067	0.	
16, 500	66, 000	. 001967	. 000034	....	....	
16, 750	67, 000	. 002000	. 000033	....	....	
17, 000	68, 000	. 002033	. 000033	....	....	Elastic limit.
17, 250	69, 000	. 002100	. 000067	....	....	
17, 500	70, 000	. 002183	. 000083	—. 000017	. 000050	
17, 750	71, 000	. 002250	. 000067	....	....	
18, 000	72, 000	. 002367	. 000117	....	....	
18, 250	73, 000	. 002483	. 000116	....	....	
18, 500	74, 000	. 002617	. 000134	....	....	
18, 750	75, 000	. 002867	. 000250	. 000467	. 000484	
19, 000	76, 000	. 003250	. 000383	....	....	
19, 250	77, 000	. 003600	. 000350	....	....	
19, 500	78, 000	. 004167	. 000567	....	....	
19, 750	79, 000	. 004867	. 000700	....	....	
20, 000	80, 000	. 005850	. 000983	. 003050	. 002583	Micrometer removed.
20, 500	82, 000	. 0083	. 002450	....	....	
21, 000	84, 000	. 0092	. 0009	....	....	
21, 500	86, 000	. 0117	. 0025	....	....	
22, 000	88, 000	. 0133	. 0016	....	....	
22, 500	90, 000	. 0150	. 0017	....	....	
23, 000	92, 000	. 0167	. 0017	....	....	
23, 500	94, 000	. 0183	. 0016	....	....	
24, 000	96, 000	. 0208	. 0025	....	....	
24, 500	98, 000	. 0233	. 0025	....	....	
25, 000	100, 000	. 0250	. 0017	....	....	
25, 500	102, 000	. 0283	. 0033	....	....	
26, 000	104, 000	. 0317	. 0034	....	....	
26, 500	106, 000	. 0350	. 0033	....	....	
27, 000	108, 000	. 0383	. 0033	....	....	
27, 500	110, 000	. 0433	. 0050	....	....	
28, 000	112, 000	. 0467	. 0034	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28, 500	114, 000	. 0550	. 0083			
29, 000	116, 000	. 0650	. 0100			
29, 400	117, 600	. 0800	. 0150			Ultimate strength.
26, 100						Load at time of fracture.

General summary.

Tensile strength per square inch of original section ....pounds.. 117, 600
Elastic limit per square inch of original section ....do... 68, 000
Elongation per inch after rupture.......... inch.. 0. 089
Elongation per inch under strain at elastic limit..........do... .002033
Reduction in diameter at point of rupture.......... do .. .104
Reduction in area after rupture, per centum of original section 33. 6
Position of rupture.......... ".6 from neck.
Character of broken surface.......... granular, radiating from dull spot at center.
Elongation of inch sections..........(".23 fractured section) ".08, ".06, ".06, ".05, ".05

No. 268.

Tension test.

Marks on bar M.B$_x$—2.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.		0.		Initial load.
1, 250	5, 000	. 000050	. 000050	—. 000017	—. 000017	
2, 500	10, 000	. 000200	. 000150	—. 000017	0.	
3, 750	15, 000	. 000367	. 000167	—. 000033	—. 000016	
5, 000	20, 000	. 000533	. 000166	—. 000033	0.	
6, 250	25, 000	. 000683	. 000150	—. 000033	0.	
7, 500	30, 000	. 000867	. 000184	—. 000033	0.	
8, 750	35, 000	. 001033	. 000166	—. 000017	. 000016	
10, 000	40, 000	. 001183	. 000150	—. 000017	0.	
10, 250	41, 000	. 001200	. 000117			
10, 500	42, 000	. 001233	. 000033			
10, 750	43, 000	. 001267	. 000034			
11, 000	44, 000	. 001300	. 000033			
11, 250	45, 000	. 001333	. 000033	—. 000017	0.	
11, 500	46, 000	. 001383	. 000050			
11, 750	47, 000	. 001400	. 000017			
12, 000	48, 000	. 001417	. 000017			
12, 250	49, 000	. 001450	. 000033			
12, 500	50, 000	. 001517	. 000067	—. 000033	—. 000016	
12, 750	51, 000	. 001550	. 000033			
13, 000	52, 000	. 001567	. 000017			
13, 250	53, 000	. 001600	. 000033			
13, 500	54, 000	. 001633	. 000033			
13, 750	55, 000	. 001683	. 000050	—. 000033	0.	
14, 000	56, 000	. 001717	. 000034			
14, 250	57, 000	. 001733	. 000016			
14, 500	58, 000	. 001783	. 000050			
14, 750	59, 000	. 001833	. 000050			
15, 000	60, 000	. 001883	. 000050	—. 000033	0.	
15, 250	61, 000	. 001883	0.			
15, 500	62, 000	. 001917	. 000034			
15, 750	63, 000	. 001967	. 000050			
16, 000	64, 000	. 002033	. 000066			
16, 250	65, 000	. 002067	. 000034	. 000017	. 000050	Elastic limit.
16, 500	66, 000	. 002133	. 000066			
16, 750	67, 000	. 002217	. 000084			

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
17, 000	68, 000	.002383	.000166	....	....	
17, 250	69, 000	.002550	.000167	....	....	
17, 500	70, 000	.002950	.000400	.000617	.000600	
17, 750	71, 000	.003433	.000483	....	....	
18, 000	72, 000	.004633	.001200	....	....	
18, 250	73, 000	.005233	.000600	....	....	
18, 500	74, 000	.006317	.001084	....	....	
18, 750	75, 000	.007367	.001050	.004650	.004033	
19, 000	76, 000	.008050	.000683	....	....	
19, 250	77, 000	.008817	.000767	....	....	
19, 500	78, 000	.009933	.001116	....	....	
19, 750	79, 000	.011033	.001100	.008833	.004183	Micrometer removed.
20, 000	80, 000	.011900	.000867	....	....	
20, 500	82, 000	.0133	.0014	....	....	
21, 000	84, 000	.0158	.0025	....	....	
21, 500	86, 000	.0175	.0017	....	....	
22, 000	88, 000	.0200	.0025	....	....	
22, 500	90, 000	.0233	.0033	....	....	
23, 000	92, 000	.0250	.0017	....	....	
23, 500	94, 000	.0283	.0033	....	....	
24, 000	96, 000	.0300	.0017	....	....	
24, 500	98, 000	.0333	.0033	....	....	
25, 000	100, 000	.0375	.0042	....	....	
25, 500	102, 000	.0417	.0042	....	....	
26, 000	104, 000	.0467	.0050	....	....	
26, 500	106, 000	.0517	.0050	....	....	
27, 000	108, 000	.0600	.0083	....	....	
27, 500	110, 000	.0750	.0150	....	....	
28, 000	112, 000	.1050	.0300	....	....	Ultimate strength.
24, 500	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity		7.8543
Hardness		26.67
Tensile strength per square inch of original section	pounds	112, 000
Elastic limit per square inch of original section	do	65, 000
Elongation per inch after rupture	inch	0.158
Elongation per inch under strain at elastic limit	do	.002067
Reduction in diameter at point of rupture	do	.124
Reduction in area after rupture, per centum of original section		89.2
Position of rupture		1¾" from neck.
Character of broken surface		granular, 60 per cent.; radiating from a dull center, 40 per cent.
Elongation of inch sections		".14 (".32 fractured section), ".14, ".12, ".12, ".08.

No. 273.

Tension test.

Marks on bar, M. B_1—3.
Length, 3".
Diameter, ".560.
Sectional area, .246 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
246	1, 000	0.	....	0.	....	Initial load.
1, 230	5, 000	.000233	.000233	.000033	.000033	
2, 460	10, 000	.000400	.000167	.000067	.000034	
3, 690	15, 000	.000567	.000167	.000067	0.	
4, 920	20, 000	.000667	.000100	.000067	0.	
6, 150	25, 000	.000800	.000133	.000067	0.	
7, 380	30, 000	.001067	.000267	.000067	0.	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
8, 610	35, 000	.001167	.000100	.000067	0.	
9, 840	40, 000	.001333	.000166	.000067	0.	
10, 086	41, 000	.001400	.000067	....	....	
10, 332	42, 000	.001400	0.	....	....	
10, 578	43, 000	.001400	0.	....	....	
10, 824	44, 000	.001467	.000067	....	....	
11, 070	45, 000	.001567	.000100	.000067	0.	
11, 318	46, 000	.001567	0.	....	....	
11, 562	47, 000	.001667	.000100	....	....	
11, 808	48, 000	.001733	.000066	....	....	
12, 054	49, 000	.001733	0.	....	....	
12, 300	50, 000	.001767	.000034	....	....	
12, 546	51, 000	.001767	0.	....	....	
12, 792	52, 000	.001767	0.	....	....	
13, 082	53, 000	.001800	.000033	....	....	
13, 284	54, 000	.001800	0.	....	....	
13, 530	55, 000	.001833	.000033	.000067	0.	
13, 776	56, 000	.001833	0.	....	....	
14, 022	57, 000	.001967	.000134	....	....	
14, 268	58, 000	.002033	.000066	....	....	
14, 514	59, 000	.002067	.000034	....	....	
14, 760	60, 000	.002100	.000033	.000067	0.	
15, 006	61, 000	.002100	0.	....	....	
15, 252	62, 000	.002133	.000033	....	....	
15, 498	63, 000	.002167	.000034	....	....	
15, 744	64, 000	.002167	0.	....	....	
15, 990	65, 000	.002200	.000033	.000067	0.	
16, 236	66, 000	.002233	.000033	....	....	
16, 482	67, 000	.002333	.000100	....	....	
16, 728	68, 000	.002367	.000034	....	....	
16, 974	69, 000	.002400	.000033	....	....	
17, 220	70, 000	.002433	.000033	.000067	0.	
17, 466	71, 000	.002467	.000034	....	....	Elastic limit.
17, 712	72, 000	.002667	.000200	....	....	
17, 958	73, 000	.002733	.000066	....	....	
18, 204	74, 000	.003333	.000600	....	....	
18, 450	75, 000	.003733	.000400	.001400	.001333	
18, 696	76, 000	.004333	.000600	....	....	
18, 942	77, 000	.005233	.000900	....	....	
19, 188	78, 000	.006233	.001000	....	....	
19, 434	79, 000	.007133	.000900	....	....	
19, 680	80, 000	.008067	.000934	.005233	.003833	Micrometer removed.
20, 172	82, 000	.0100	.001933	....	....	
20, 664	84, 000	.0133	.0033	....	....	
21, 156	86, 000	.0167	.0034	....	....	
21, 648	88, 000	.0183	.0016	....	....	
22, 140	90, 000	.0200	.0017	....	....	
22, 632	92, 000	.0217	.0017	....	....	
23, 124	94, 000	.0233	.0016	....	....	
23, 616	96, 000	.0267	.0034	....	....	
24, 108	98, 000	.0283	.0016	....	....	
24, 600	100, 000	.0300	.0017	....	....	
25, 092	102, 000	.0333	.0033	....	....	
25, 584	104, 000	.0383	.0050	....	....	
26, 076	106, 000	.0400	.0017	....	....	
26, 568	108, 000	.0467	.0067	....	....	
27, 060	110, 000	.0500	.0033	....	....	
27, 552	112, 000	.0567	.0067	....	....	
28, 044	114, 000	.0667	.0100	....	....	
28, 536	116, 000	.0900	.0233	....	....	
28, 650	116, 460	.1033	.1033	....	....	Ultimate strength.
25, 200	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section....................pounds.. 116, 460
Elastic limit per square inch of original section....................do... 71, 000
Elongation per inch after rupture....................inch.. 0. 16
Elongation per inch under strain at elastic limit....................do... .002467
Reduction in diameter at point of rupture....................do... 0. 110
Reduction in area after rupture, per centum of original section.................... 35. 4
Position of rupture....................⅜″ from neck
Character of broken surface..........granular, 80 per cent.; radiating from a dull center, 20 per cent.
Elongation of inch sections....................(″.26 fractured section) ″.12, ″.10

No. 274.

Tension test.

Marks on bar, M. B_x—4.
Length, 3″.
Diameter, ″.559.
Sectional area, .245 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
245	1, 000	0.	....	0.	....	Initial load.
1, 225	5, 000	0.	....	0.	....	
2, 450	10, 000	.000267	.000267	0.	....	
3, 675	15, 000	.000333	.000066	0.	....	
4, 900	20, 000	.000400	.000067	0.	....	
6, 125	25, 000	.000500	.000100	0.	....	
7, 350	30, 000	.000667	.000167	0.	....	
8, 575	35, 000	.000933	.000266	0.	....	
9, 800	40, 000	.001000	.000067	0.	....	
11, 025	45, 000	.001267	.000267	0.	....	
12, 250	50, 000	.001333	.000066	0.	....	
12, 495	51, 000	.001333	0.	....	....	
12, 740	52, 000	.001367	.000034	....	....	
12, 985	53, 000	.001367	0.	....	....	
13, 230	54, 000	.001400	.000033	....	....	
13, 475	55, 000	.001400	0.	0.	....	
13, 720	56, 000	.001533	.000133	....	....	
13, 965	57, 000	.001600	.000067	....	....	
14, 210	58, 000	.001667	.000067	....	....	
14, 455	59, 000	.001667	0.	....	....	
14, 700	60, 000	.001667	0.	0.	....	
14, 945	61, 000	.001733	.000066	....	....	
15, 190	63, 000	.901833	.000100	....	....	
15, 435	62, 000	.001933	.000100	....	....	
15, 680	64, 000	.002000	.000067	....	....	Elastic limit.
15, 925	65, 000	.002333	.000333	.000333	.000333	
16, 170	66, 000	.002600	.000267	....	....	
16, 415	67, 000	.002833	.000233	....	....	
16, 660	68, 000	.003267	.000434	....	....	
16, 905	69, 000	.004267	.001000	....	....	
17, 150	70, 000	.005000	.000733	.002667	.002334	
17, 395	71, 000	.005600	.000600	....	....	
17, 640	72, 000	.006333	.000733	....	....	
17, 885	73, 000	.007267	.000934	....	....	
18, 130	74, 000	.008267	.001000	....	....	
18, 375	75, 000	.009000	.000733	.006333	.003666	
18, 620	76, 000	.009833	.000833	....	....	
18, 865	77, 000	.010833	.000500	....	....	
19, 110	78, 000	.011500	.001167	....	....	
19, 355	79, 000	.012267	.000767	....	....	
19, 600	80, 000	.013667	.001400	.010667	.004334	Micrometer removed.
20, 090	82, 000	.0167	.003033	....	....	
20, 580	84, 000	.0183	.0016	....	....	
21, 070	86, 000	.0200	.0017	....	....	
21, 560	88, 000	.0217	.0017	....	....	
22, 050	90, 000	.0233	.0016	....	....	
22, 540	92, 000	.0267	.0034	....	....	
23, 030	94, 000	.0283	.0016	....	....	
23, 520	96, 000	.0300	.0017	....	....	
24, 010	98, 000	.0333	.0033	....	....	
24, 500	100, 000	.0367	.0034	....	....	
24, 990	102, 000	.0417	.0050	....	....	
25, 480	104, 000	.0500	.0083	....	....	
25, 970	106, 000	.0550	.0050	....	....	
26, 460	108, 000	.0617	.0067	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
26,950	110,000	.0767	.0150	....	....	
27,440	112,000	.0900	.0133	....	....	
27,600	112,650	.1100	.0200	....	....	Ultimate strength.
25,600	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity	7.8556
Hardness	26.99
Tensile strength per square inch of original section ....pounds	112,650
Elastic limit per square inch of original section ....do	64,000
Elongation per inch after rupture ....inch	0.16
Elongation per inch under strain at elastic limit ....do	.002000
Reduction in diameter at point of rupture ....do	.089
Reduction in area after rupture, per centum of original section	29.3
Position of rupture	¼" from middle of stem
Character of broken surface	granular; small dull spot near the center of the fractured surface
Elongation of inch sections	".13 (".25 fractured section) ".16

No. 312.

Tension test.

Marks on bar, $^{\mathrm{M.}\ \mathrm{Bx}}_{\quad\mathrm{a}}$
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	0.	0.	0.	Initial load.
1,250	5,000	.000117	.000117	0.	....	
2,500	10,000	.000233	.000116	0.	....	
3,750	15,000	.000400	.000167	0.	....	
5,000	20,000	.000550	.000150	0.	....	
6,250	25,000	.000667	.000117	0.	....	
7,500	30,000	.000833	.000166	0.	....	
8,750	35,000	.001000	.000167	0.	....	
10,000	40,000	.001183	.000183	.000017	.000017	
10,250	41,000	.001200	.000017	....	....	
10,500	42,000	.001233	.000033	....	....	
10,750	43,000	.001267	.000034	....	....	
11,000	44,000	.001300	.000033	....	....	
11,250	45,000	.001333	.000033	.000033	.000016	
11,250	46,000	.001383	.000050	....	....	
11,750	47.000	.001400	.000017	....	....	
12,000	48,000	.001450	.000050	....	....	
12,250	49,000	.001500	.000050	....	....	
12,500	50,000	.001533	.000033	.000050	.000017	
12,750	51,000	.001567	.000034	....	....	
13,000	52,000	.001617	.000050	....	....	
13,250	53,000	.001667	.000050	....	....	
13,500	54,000	.001700	.000033	....	....	
13,750	55,000	.001733	.000033	.000100	.000050	
14,000	56,000	.001800	.000067	....	....	
14,250	57,000	.001867	.000067	....	....	Elastic limit.
14,500	58,000	.001967	.000100	....	....	
14,750	59,000	.002033	.000066	....	....	
15,000	60,000	.002233	.000200	.000350	.000250	
15,250	61,000	.002400	.000167	....	....	
15,500	62,000	.002617	.000217	....	....	
15,750	63,000	.002900	.000283	....	....	
16,000	64,000	.003333	.000433	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16, 250	65, 000	.003833	.000500	.001650	.001300	
16, 500	66, 000	.004617	.000784	....	....	
16, 750	67, 000	.005233	.000616	....	....	
17, 000	68, 000	.005950	.000717	....	....	
17, 250	69, 000	.006600	.000650	....	....	
17, 500	70, 000	.007583	.000983	.005217	.003567	
18, 000	72, 000	.008950	.001367	....	....	
18, 500	74, 000	.010867	.001917	....	....	
19, 000	76, 000	.012683	.001816	....	....	
19, 500	78, 000	.014333	.001650	....	....	
20, 000	80, 000	.016517	.002184	....	....	
20, 500	82, 000	.018400	.001883	....	....	
21, 000	84, 000	.020100	.001700	....	....	
21, 500	86, 000	.022250	.002150	....	....	
22, 000	88, 000	.024250	.002000	....	....	
22, 500	90, 000	.026450	.002200	....	....	
23, 000	92, 000	.029517	.003067	....	....	
23, 500	94, 000	.032833	.003316	....	....	
24, 000	96, 000	.035117	.002284	....	....	
24, 500	98, 000	.039450	.004333	....	....	
25, 000	100, 000	.043917	.004467	....	....	Micrometer removed.
25, 500	102, 000	.0467	.002783	....	....	
26, 000	104, 000	.0550	.0083	....	....	
26, 500	106, 000	.0633	.0083	....	....	
27, 000	108, 000	.0817	.0184	....	....	
27, 110	108, 440	.0967	.0150	....	....	Ultimate strength.
25, 200	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section ....pounds..	108, 440
Elastic limit per square inch of original section ....do....	57, 000
Elongation per inch after rupture ....inch..	0. 105
Elongation per inch under strain at elastic limit....................do...	.001867
Reduction in diameter at point of rupture....................do...	.104
Reduction in area after rupture, per centum of original section	33. 6
Position of rupture....................	".70 from neck.
Character of broken surface	granular, dull center.
Elongation of inch sections....................	".07, ".08, ".07, ".08, ".09 (".24 fractured section).

No. 313.

Tension test.

Marks on bar, $^{\text{M.Bx}}_{6}$.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000117	.000117	0.	....	
2, 500	10, 000	.000283	.000166	0.	....	
3, 750	15, 000	.000450	.000167	0.	....	
5, 000	20, 000	.000617	.000167	.000017	.000017	
6, 250	25, 000	.000750	.000133	.000017	0.	
7, 500	30, 000	.000900	.000150	.000017	0.	
8, 750	35, 000	.001067	.000167	.000017	0.	
10, 000	40, 000	.001233	.000166	.000017	0.	
10, 250	41, 000	.001250	.000017	....	....	
10, 500	42, 000	.001283	.000033	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
10,750	43,000	.001317	.000034	....	....	
11,000	44,000	.001350	.000033	....	....	
11,250	45,000	.001383	.000033	.000033	.000016	
11,500	46,000	.001417	.000034	....	....	
11,750	47,000	.001450	.000033	....	....	
12,000	48,000	.001483	.000033	....	....	
12,250	49,000	.001517	.000034	....	....	
12,500	50,000	.001550	.000033	.000050	.000017	
12,750	51,000	.001583	.000033	....	....	
13,000	52,000	.001617	.000034	....	....	
13,250	53,000	.001650	.000033	....	....	
13,500	54,000	.001700	.000050	....	....	
13,750	55,000	.001733	.000033	.000050	0.	
14,000	56,000	.001783	.000050	....	....	
14,250	57,000	.001817	.000034	....	....	
14,500	58,000	.001850	.000033	....	....	
14,750	59,000	.001883	.000033	....	....	
15,000	60,000	.001917	.000034	.000067	.000017	
15,250	61,000	.001950	.000033	....	....	
15,500	62,000	.002000	.000050	....	....	
15,750	63,000	.002033	.000033	....	....	
16,000	64,000	.002067	.000034	....	....	
16,250	65,000	.002100	.000033	.000083	.000016	
16,500	66,000	.002200	.000100	....	....	
16,750	67,000	.002250	.000050	....	....	Elastic limit.
17,000	68,000	.002367	.000117	....	....	
17,250	69,000	.002433	.000066	....	....	
17,500	70,000	.002700	.000267	.000450	.000367	
17,750	71,000	.002933	.000233	....	....	
18,000	72,000	.003400	.000467	....	....	
18,250	73,000	.004067	.000667	....	....	
18,500	74,000	.004817	.000750	....	....	
18,750	75,000	.005550	.000733	....	....	
19,000	76,000	.006933	.001383	....	....	
19,500	78,000	.008550	.001617	....	....	
20,000	80,000	.010383	.001833	....	....	
20,500	82,000	.012500	.002117	....	....	
21,000	84,000	.014083	.001583	....	....	
21,500	86,000	.015850	.001767	....	....	
22,000	88,000	.018083	.002233	....	....	
22,500	90,000	.020650	.002567	....	....	
23,000	92,000	.022383	.001683	....	....	
23,500	94,000	.024333	.002000	....	....	
24,000	96,000	.027400	.003067	....	....	
24,500	98,000	.030333	.002933	....	....	
25,000	100,000	.033000	.002667	....	....	Micrometer removed.
25,500	102,000	.0367	.0037	....	....	
26,000	104,000	.0400	.0033	....	....	
26,500	106,000	.0450	.0050	....	....	
27,000	108,000	.0500	.0050	....	....	
27,500	110,000	.0617	.0117	....	....	
28,000	112,000	.0717	.0100	....	....	
28,500	114,000	.1050	.0333	....	....	Ultimate strength.
25,200	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	114,000
Elastic limit per square inch of original section	do....	67,000
Elongation per inch after rupture	inch..	0.1283
Elongation per inch under strain at elastic limit	do....	.002250
Reduction in diameter at point of rupture	do....	.094
Reduction in area after rupture, per centum of original section		30.8
Position of rupture		¾″ from neck.
Character of broken surface		granular; dull spot near center.
Elongation of inch sections		″.08, ″.09, ″.09, ″.12, ″.14 (″.25 fractured section).

No. 375.

Compression test.

Marks on bar, $\frac{\text{M.Bx}}{7}$.
Length, 11″.97.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
5, 000	5, 000	.000140	.000140	0.	....	
10, 000	10, 000	.000280	.000140	0.	....	
15, 000	15, 000	.000440	.000160	.000010	.000010	
20, 000	20, 000	.000600	.000160	.000010	0.	
25, 000	25, 000	.000750	.000150	.000010	0.	
30, 000	30, 000	.000930	.000180	.000010	0.	
35, 000	35, 000	.001100	.900170	.000020	.000010	
40, 000	40, 000	.001250	.000150	.000020	0.	
41, 000	41, 000	.001290	.000040	....	....	
42, 000	42, 000	.001310	.000020	....	....	
43, 000	43, 000	.001370	.000060	....	....	
44, 000	44, 000	.001400	.000030	....	....	
45, 000	45, 000	.001430	.000030	.000030	.000030	
46, 000	46, 000	.001470	.000040	....	....	
47, 000	47, 000	.001490	.000020	....	....	
48, 000	48, 000	.001510	.000020	....	....	
49, 000	49, 000	.001570	.000065	....	....	
50, 000	50, 000	.001590	.000020	.000040	.000010	
51, 000	51, 000	.001630	.000040	....	....	
52, 000	52, 000	.001670	.000040	....	....	
53, 000	53, 000	.001710	.000040	....	....	
54, 000	54, 000	.001740	.000030	....	....	
55, 000	55, 000	.001770	.000030	.000050	.000010	Perceptible deflection.
56, 000	56, 000	.001830	.000060	....	....	
57, 000	57, 000	.001870	.000040	....	....	
58, 000	58, 000	.001930	.000060	....	....	
59, 000	59, 000	.001990	.000060	....	....	
60, 000	60, 000	.002130	.000140	.000180	.000130	
61, 000	61, 000	.002280	.000150	....	....	Rapid deflection going on.
62, 000	62, 000	.002480	.000200	....	....	
63, 000	63, 000	.002780	.000300	....	....	
64, 000	64, 000	.003080	.000300	....	....	
65, 000	65, 000	.003770	.000690	.001580	.001400	Micrometer removed.
68, 400	68, 400	....	....	....	....	Middle deflection ″.10.
69, 400	69, 400	....	....	....	....	Middle deflection″.17. Ultimate strength.

Failed by triple flexure.

No. 104.

Tension test.

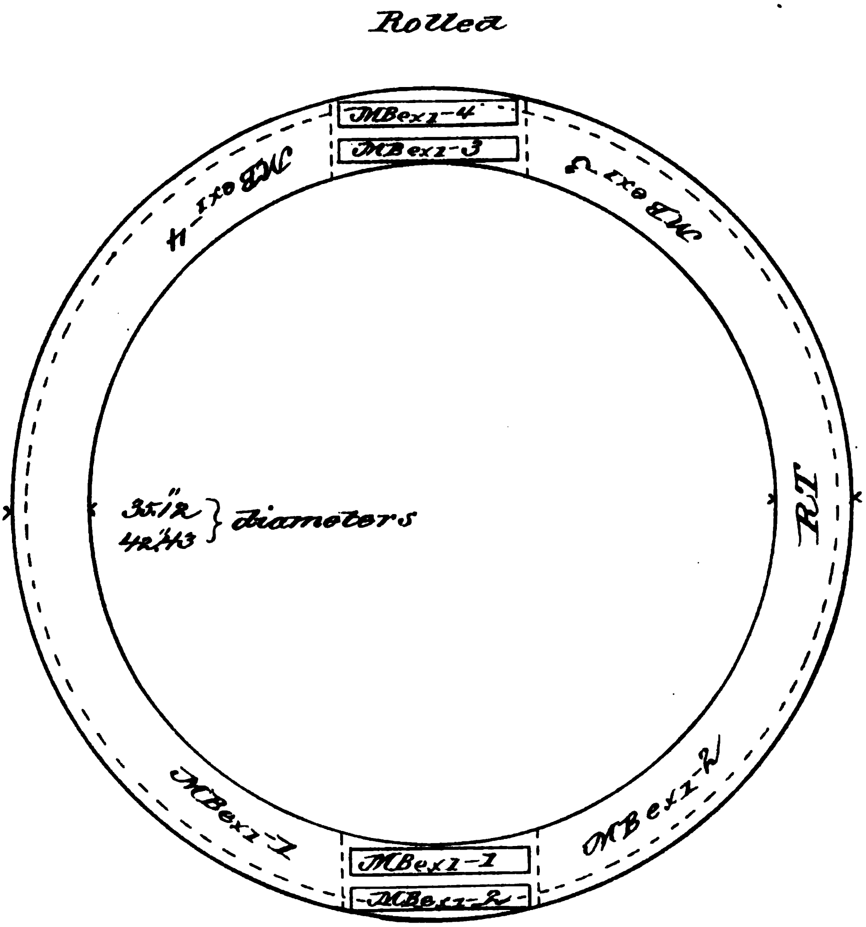
Marks on bar, M B$_{EX\ 1}$—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	.....	....	....	Initial load.
1,250	5,000	.000117	.000117	0.	....	
2,500	10,000	.000237	.000120	.000017	.000017	
3,750	15,000	.000367	.000130	.000033	.000016	
5,000	20,000	.000517	.000150	.000033	0.	
6,250	25,000	.000683	.000166	.000050	.000017	
7,500	30,000	.000833	.000150	.000033	.000017	
8,750	35,000	.000983	.000150	.000033	0.	
10,000	40,000	.001167	.000184	.000033	0.	
11,250	45,000	.001300	.000133	.000033	0.	
12,500	50,000	.001467	.000167	.000033	0.	
12,750	51,000	.001500	.000033	....	....	
13,000	52,000	.001533	.000033	....	....	
13,250	53,000	.001550	.000017	....	....	
13,500	54,000	.001567	.000017	....	....	
13,750	55,000	.001617	.000050	.000033	0.	
14,000	56,000	.001667	.000050	....	....	
14,250	57,000	.001683	.000016	....	....	
14,500	58,000	.001700	.000017	....	....	
14,750	59,000	.001733	.000033	....	....	
15,000	60,000	.001767	.000034	.000017	.000016	
15,250	61,000	.001833	.000066	....	....	
15,500	62,000	.001867	.000034	....	....	Elastic limit.
15,750	63,000	.001983	.000116	....	....	
16,000	64,000	.002183	.000200	....	....	
16,250	65,000	.002467	.000324	.000400	.000417	
16,500	66,000	.002850	.000383	....	....	
16,750	67,000	.003300	.000450	....	....	
17,000	68,000	.004017	.000717	....	....	
17,250	69.000	.004567	.000550	....	....	
17,500	70,000	.005517	.000950	.003067	.002667	
18,000	72.000	.006850	.001333	....	....	
18,500	74,000	.008650	.001800	....	....	
19,000	76,000	.010200	.001550	....	....	
19,500	78,000	.011667	.001467	....	....	
20,000	80,000	.013417	.001750	.010250	.007183	Micrometer removed.
20,500	82,000	.0150	.001583	....	....	
21,000	84,000	.0167	.0017	....	....	
21,500	86,000	.0183	.0016	....	....	
22,000	88,000	.0217	.0034	....	....	
22,500	90,000	.0233	.0016	....	....	
23,000	92,000	.0250	.0017	....	....	
23,500	94,000	.0267	.0017	....	....	
24,000	96,000	.0317	.0050	....	....	
24,500	98.000	.0333	.0016	....	....	
25,000	100,000	.0367	.0034	....	....	
25,500	102,000	.0400	.0033	....	....	
26,000	104,000	.0467	.0067	....	....	
26,500	106,000	.0500	.0033	....	....	
27,000	108,000	.0583	.0083	....	....	
27,500	110,000	.0700	.0117	....	....	
28,000	112,000	.0867	.0167	....	....	
28,250	113,000	.0933	.0066	....	....	Ultimate strength.
25,400	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	113,000
Elastic limit per square inch of original section	do....	62,000
Elongation per inch after rupture	inch..	0.135
Elongation per inch under strain at elastic limit	do....	.001867
Reduction in diameter at point of rupture	do....	.104
Reduction in area after rupture, per centum of original section		33.6
Position of rupture		″.8 from neck.
Character of broken surface		Granular, radiating from smoky spot at center.

1st ring from Hoop Bex
12 inch Mortar



S Ex 35 49 1

No. 105.

Tension test.

Marks on bar, M. $B_{ex.1}$—2.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads. Total.	Applied loads. Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.				Initial load.
1, 250	5, 000	.000100	.000100	0.		
2, 500	10, 000	.000233	.000133	0.		
3, 750	15, 000	.000383	.000150	0.		
5, 000	20, 000	.000517	.000134	—.000017	—.000017	
6. 250	25, 000	.000650	.000133	—.000033	—.000016	
7, 500	30, 000	.000817	.000167	—.000033	0.	
8, 750	35, 000	.000983	.000166	—.000050	—.000017	
10, 000	40, 000	.001133	.000150	—.000050	0.	
11, 250	45, 000	.001267	.000134	—.000050	0.	
12, 500	50, 000	.001433	.000166	—.000050	0.	
12, 750	51, 000	.001500	.000067	—.000033	.000017	
13, 000	52, 000	.001533	.000033			
13, 250	53, 000	.001567	.000034			
13, 500	54, 000	.001600	.000033			Elastic limit.
13, 750	55, 000	.001667	.000067	.000033	.000066	
14, 000	56, 000	.002433	.000766			
14, 250	57, 000	.002933	.000500			
14, 500	58, 000	.003517	.000584			
14, 750	59, 000	.003917	.000400			
15, 000	60, 000	.004483	.000566	.002400	.002367	
15, 250	61, 000	.005150	.000667			
15, 500	62, 000	.005783	.000633			
15, 750	63, 000	.006317	.000534			
16, 000	64, 000	.007183	.000866			
16, 250	65, 000	.007833	.000650	.005433	.003033	
16, 500	66, 000	.008500	.000667			
16, 750	67, 000	.009267	.000767			
17, 000	68, 000	.009967	.000700			
17, 250	69, 000	.010483	.000516			
17, 500	70, 000	.011533	.001050	.008867	.003434	
18, 000	72, 000	.012950	.001417			
18, 500	74, 000	.014983	.002033			
19, 000	76, 000	.016883	.001900			
19, 500	78, 000	.018717	.001834			
20, 000	80, 000	.020633	.001916	.017233	.008366	Micrometer removed.
20, 500	82, 000	.0233	.002677			
21, 000	84, 000	.0267	.0034			
21, 500	86, 000	.0300	.0033			
22, 000	88, 000	.0317	.0017			
22, 500	90, 000	.0342	.0025			
23, 000	92, 000	.0383	.0041			
23, 500	94. 000	.0400	.0017			
24, 000	96, 000	.0440	.0050			
24, 500	98 000	.0517	.0067			
25, 000	100, 000	.0567	.0050			
25, 500	102, 000	.0667	.0100			
26, 000	104, 000	.0800	.0133			
26, 500	106, 000	.1017	.0217			
26, 680	106, 720	.1150	.0133			Ultimate strength.
24, 000						Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	106, 720
Elastic limit per square inch of original section	do....	54, 000
Elongation per inch after rupture	inch..	0. 14
Elongation per inch under strain at elastic limit	do...	.001600
Reduction in diameter at point of rupture	do...	.114
Reduction in area after rupture, per centum of original section		36. 4
Position of rupture		″.6 from middle of specimen.
Character of broken surface		Granular, radiating from smoky spot at center.

No. 106.

Tension test.

Marks on bar, M. B$_{ex1}$—3.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000133	.000133	0.	....	
2,500	10,000	.000283	.000150	0.	....	
3,750	15,000	.000417	.000134	0.	....	
5,000	20,000	.000550	.000133	0.	....	
6,250	25,000	.000700	.000150	0.	....	
7,500	30,000	.000850	.000150	0.	....	
8,750	35,000	.001000	.000150	0.	....	
10,000	40,000	.001167	.000167	.000017	.000017	
11,250	45,000	.001333	.000166	.000017	0.	
12,500	50,000	.001500	.000167	.000050	.000033	
12,750	51,000	.001550	.000050	....	....	
13,000	52,000	.001567	.000017	....	....	
13,250	53,000	.001600	.000033	....	....	
13,500	54,000	.001650	.000050	....	....	
13,750	55,000	.001683	.000033	.000067	.000017	
14,000	56,000	.001700	.000017	....	....	
14,250	57,000	.001733	.000033	....	....	
14,500	58,000	.001783	.000050	....	....	
14,750	59,000	.901817	.000034	....	....	
15,000	60,000	.001833	.000016	.000083	.000016	
15,250	61,000	.001867	.000034	....	....	
15,500	62,000	.001917	.000050	....	....	
15,750	63,000	.001967	.000050	....	....	
16,000	64,000	.002000	.000033	....	....	Elastic limit.
16,250	65,000	.002083	.000083	.000133	.000050	
16,500	66,000	.002200	.000117	....	....	
16,750	67,000	.002350	.000150	....	....	
17,000	68,000	.002567	.000217	....	....	
17,250	69,000	.002933	.000366	....	....	
17,500	70,000	.003650	.000717	.001350	.001217	Rested ½ hour under initial load.
17,750	71,000	.003983	.000233	....	....	
18,000	72,000	.004817	.000834	....	....	
18,250	73,000	.005333	.000516	....	....	
18,500	74,000	.006483	.001150	....	....	
18,750	75,000	.007167	.000684	.004500	.003150	
19,000	76,000	.007817	.000650	....	....	
19,250	77,000	.008533	.000716	....	....	
19,500	78,000	.009450	.000917	....	....	
19,750	79,000	.010200	.000750	....	....	
20,000	80,000	.011517	.001317	.008500	.004000	
20,250	81,000	.011933	.000416	....	....	
20,500	82,000	.012350	.000417	....	....	
20,750	83,000	.013233	.000883	....	....	
21,000	84,000	.014500	.001267	....	....	
21,250	85,000	.015583	.001083	.012283	.003783	
21,500	86,000	.016333	.000750	....	....	
21,750	87,000	.016983	.000650	....	....	
22,000	88,000	.018017	.001034	....	....	
22,250	89,000	.019117	.001100	....	....	
22,500	90,000	.020600	.001483	.017000	.004717	Micrometer removed.
23,000	92,000	.0233	.0027	....	....	
23,500	94,000	.0267	.0034	....	....	
24,000	96,000	,0300	.0033	....	....	
24,500	98,000	.0333	.0033	....	....	
25,000	100,000	.0350	.0017	....	....	
25,500	102,000	.0383	.0033	....	....	
26,000	104,000	.0417	.0034	....	....	
26,500	106,000	.0467	.0050	....	....	
27,000	108,000	.0533	.0066	....	....	
27,500	110,000	.0600	.0067	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28,000	112,000	.0733	.0183	....	....	
28,500	114,000	.0883	.0150	....	....	
28,750	115,000	.1133	.0250	....	....	Ultimate strength.
25,800	....	....	....	....	....	Load at time of fracture.

General summary.

Hardness		24.84
Tensile strength per square inch of original section	pounds..	115,000
Elastic limit per square inch of original section	do...	64,000
Elongation per inch after rupture	inch..	0.143
Elongation per inch under strain at elastic limit	do...	.002000
Reduction in diameter at point of rupture	do...	.104
Reduction in area after rupture, per centum of original section		33.6
Position of rupture		".8 from neck.
Character of broken surface		granular, radiating from a smoky spot at center

No. 107.

Tension test.

Marks on bar, M. B_{ex1}—4.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000100	.000100	0.	....	
2,500	10,000	.000250	.000150	0.	....	
3,750	15,000	.000400	.000150	0.	....	
5,000	20,000	.000550	.000150	0.	....	
6,250	25,000	.000700	.000150	0.	....	
7,500	30,000	.000900	.000200	0.	....	
8,750	35,000	.001050	.000150	0.	....	
10,000	40,000	.001217	.000166	0.	....	
11,250	45,000	.001383	.000167	.000017	.000017	
12,500	50,000	.001550	.000167	.000017	0.	
12,750	51,000	.001583	.000033	....	....	
13,000	52,000	.001617	.000034	....	....	
13,250	53,000	.001650	.000033	....	....	
13,500	54,000	.001717	.000067	....	....	
13,750	55,000	.001750	.000033	000033	.000016	
14,000	56,000	.001817	.000067	....	....	
14,250	57,000	.001883	.000066	....	....	
14,500	58,000	.001917	.000034	....	....	
14,750	59,000	.001967	.000050	....	....	Elastic limit.
15,000	60,000	.002050	.000083	.000150	.000117	
15,250	61,000	.002200	.000150	....	....	
15,500	62,000	.002400	.000200	....	....	
15,750	63,000	.002550	.000150	....	....	
16,000	64,000	.002917	.000367	....	....	
16,250	65,000	.003317	.000400	.001133	.000983	Rested one hour under initial load.
16,500	66,000	.003850	.000533	....	....	
16,750	67,000	.004433	.000583	....	....	
17,000	68,000	.005383	.000950	....	....	
17,250	69,000	.005900	.000517	....	....	
17,500	70,000	.006817	.000917	.004300	.003167	
18,000	72,000	.008333	.001516	....	....	
18,500	74,000	.009333	.001000	....	....	

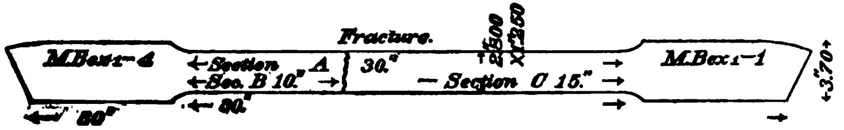
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
19, 000	76, 000	.011300	.001967	....	....	
19, 500	78, 000	.013467	.002167	....	....	
20, 000	80, 000	.015050	.001583	.011750	.007450	
20, 500	82, 000	.016383	.001333	....	....	
21. 000	84, 000	.018650	.002267	....	....	
21, 500	86, 000	.020517	.001867	....	....	
22, 000	88, 000	.023033	.002516	....	....	
22, 500	90, 000	.025100	.002067	.021233	.009483	Micrometer removed.
23, 000	92, 000	.0267	.0016	....	....	
23, 500	94, 000	.0300	.0033	....	....	
24, 000	96, 000	.0333	.0033	....	....	
24, 500	98, 000	.0383	.0050	....	....	
25, 000	100, 000	.0417	.0034	....	....	
25, 500	102, 000	.0450	.0033	....	....	
26, 000	104, 000	.0517	.0067	....	....	
26. 500	106, 000	.0583	.0066	....	....	
27, 000	108, 000	.0683	.0100	....	....	
27, 500	110, 000	.0917	.0234	....	....	
27, 580	110, 320	.1050	.0133	....	....	Ultimate strength.
25, 300	....	....	....	....	....	Load at time of fracture.

General summary.

Hardness		24[illegible]
Tensile strength per square inch of original section	pounds..	110, 320
Elastic limit per square inch of original section	do...	50, 000
Elongation per inch after rupture	inch..	0.14
Elongation per inch under strain at elastic limit	do...	.001967
Reduction in diameter at point of rupture	do...	.14
Reduction in area after rupture, per centum of original section	do...	35.[illegible]
Position of rupture		".8 from middle of specimen
Character of broken surface		granular, radiating from smoky spot at center

No. 110.

Form of specimen.



Sectional area, 3.50 square inches.

Three micrometers used for measuring the elongations. The micrometer on section A covers the whole length of stem of specimen, 30 inches along the center line of the bar. The micrometer on section B covers 10 inches length, and that on section C covers 15 inches length.

Sections B and C are taken along the same side of the bar, and .20 inch from the edge.

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
3,500	1,000	0.	....	0.	....	0.	....	0.	....	0.	....	0.	....	Initial load.
17,500	5,000	.000133	.000133	0.	....	.000130	.000130	0.	....	.000127	.000127	0.	....	
35,000	10,000	.000327	.000194	0.	....	.000330	.000200	0.	....	.000293	.000166	0.	....	
52,500	15,000	.000487	.000160	0.	....	.000480	.000150	0.	....	.000460	.000167	0.	....	
70,000	20,000	.000647	.000160	0.	....	.000660	.000180	0.	....	.000633	.000173	0.	....	
87,500	25,000	.000817	.000170	0.	....	.000810	.000150	0.	....	.000793	.000160	0.	....	
105,000	30,000	.000977	.000160	0.	....	.000990	.000180	0.	....	.000960	.000167	0.	....	
122,500	35,000	.001140	.000163	0.	....	.001170	.000180	0.	....	.001120	.000160	0.	....	
140,000	40,000	.001313	.000173	0.	....	.001320	.000150	0.	....	.001280	.000160	0.	....	
143,500	41,000	.001343	.000030	....	....	.001360	.000040	....	....	.001327	.000047	....	....	
147,000	42,000	.001380	.000037	....	....	.001410	.000050	....	....	.001353	.000026	....	....	
150,500	43,000	.001417	.000037	....	....	.001430	.000020	....	....	.001393	.000040	....	....	
154,000	44,000	.001453	.000036	....	....	.001470	.000040	....	....	.001433	.000040	....	....	
157,500	45,000	.001490	.000037	.000017	.000017	.001510	.000040	0.	....	.001467	.000034	.000013	.000013	Elastic limit, sec. A.
161,000	46,000	.001533	.000043	....	....	.001540	.000030	....	....	.001513	.000046	....	....	
164,500	47,000	.001580	.000047	.000037	.000020	.001590	.000050	.000010	.000010	.001560	.000047	.000053	.000040	Elastic limit, sec. C.
168,000	48,000	.001637	.000057	....	....	.001620	.000030	....	....	.001620	.000060	....	....	
171,500	49,000	.002750	.001113	....	....	.001620	0.	....	....	.002067	.000447	....	....	Elastic limit, sec. B.

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Suuccessive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch,	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
175,000	50,000	.005637	.002887	.003737	.003700	.006510	.004890	.004550	.004540	.004000	.001933	.002207	.002154	
Measurements of the bar under the loads in the braces are to show the change in elongations when the metal has previously been strained beyond its primitive elastic limit.														
	5,000	.003867				.004660				.002353				
	10,000	.004060	.000193			.004850	.000190			.002547	.000194			
	15,000	.004237	.000177			.005050	.000200			.002713	.000166			
	20,000	.004413	.000176			.005220	.000170			.002880	.000167			
	25,000	.004600	.000187			.005420	.000200			.003060	.000180			
	30,000	.004787	.000187			.005610	.000190			.003240	.000180			
	35,000	.004973	.000186			.005810	.000200			.003413	.000173			
	40,000	.005173	.000200			.006040	.000230			.003600	.000187			
	45,000	.005400	.000227			.006280	.000240			.003807	.000207			
	50,000	.005783	.000383			.006710	.000430			.004153	.000346			
178,500	51,000	.006813	.001176			.007550	.001040			.005220	.001220			
182,000	52,000	.007660	.000847			.008270	.000720			.006480	.001260			
185,500	53,000	.008700	.001040	.006557	.002820	.009340	.001070	.007090	.002540	.007487	.001007	.005380	.003173	
189,000	54,000	.009633	.000933			.010240	.000900			.008447	.000960			
192,500	55,000	.010977	.001344	.008660	.002103	.011420	.001180	.009050	.001960	.009900	.001453	.007627	.002247	
	5,000	.008783				.009150				.007767				
	10,000	.009000	.000217			.009380	.000230			.007960	.000193			
	15,000	.009193	.000193			.009580	.000200			.008140	.000180			
	20,000	.009383	.000190			.009760	.000180			.008333	.000193			
	25,000	.009573	.000190			.009980	.000180			.008527	.000194			
	30,000	.009773	.000200			.010170	.000190			.008720	.000193			
	35,000	.009990	.000217			.010390	.000220			.008933	.000213			
	40,000	.010193	.000203			.010600	000210			.009147	.000214			
	45,000	.010433	.000240			.010860	.000260			.009373	.000226			
	50,000	.010683	.000250	.008700		.011110	.000250	.009090		.009607	.000234	.007653		
196,000	56,000	.011403	.000426			.011850	.000430			.010333	.000433			
199,500	57,000	.012403	.001000			.012850	.001000			.011393	.001060			
203,000	58,000	.013800	.001397			.014280	.001430			.012787	.001394			
206,500	59,000	.014867	.001067			.015360	.001080			.013833	.001040			
210,000	60,000	.016007	.001140	.013387	.004727	.016540	.001180	.013840	.004790	.014940	.001107	.012367	.004740	
	5,000	.013523				.013940				.012520				
	10,000	.013733	.000210			.014180	.000160			.012711	.000191			
	15,000	.013933	.000200			.014370	.000190			.012898	.000182			
	20,000	.014130	.000197			.014580	.000210			.013073	.000180			

	25, 000	.014333	.000203			.014790	.000210			.013280	.000207			
	30, 000	.014533	.000200			.014990	.000200			.013473	.000193			
	35, 000	.014743	.000210			.015200	.000210			.013680	.000207			
	40, 000	.014967	.000224			.015460	.000260			.013880	.000200			
	45, 000	.015187	.000220			.015680	.000220			.014133	.000253			
	50, 000	.015430	.000243	.013417		.015940	.000260	.013860		.014353	.000220	.012393		Rested under initial load 15 hours.
				.013400				.013850				.012373		Sets measured after resting of bar.
	5, 000	.013533				.013970				.012520				
	10, 000	.013743	.000210			.014190	.000220			.012707	.000187			
	15, 000	.013933	.000190			.014380	.000190			.012900	.000193			
	20, 000	.014140	.000203			.014600	.000220			.013087	.000187			
	25, 000	.014337	.000197			.014800	.000200			.013273	.000186			
	30, 000	.014540	.000203			.015000	.000200			.013473	.000200			
	35, 000	.014747	.000207			.015210	.000210			.013680	.000207			
	40, 000	.014953	.000206			.015460	.000250			.013900	.000220			
	45, 000	.015180	.000227			.015680	.000220			.014120	.000220			
	50, 000	.015410	.000230	.013417		.015910	.000230	.013870		.014333	.000213	.012380		
217, 000	62, 000	.018053	.002046			.018660	.002120			.016947	.002007			
224, 000	64, 000	.021683	.002630			.021410	.002750			.019600	.002653			
231, 000	66, 000	.023340	.002657			.024200	.002790			.022247	.002647			
238, 000	68, 000	.026450	.003110			.027400	.003200			.025333	.003086			
245, 000	70, 000	.029613	.003163	.026437	.013050	.030470	.003070	.027220	.013380	.028420	.003087	.025293	.012926	
	5, 000	.026567				.027340				.025413				
	10, 000	.026767	.000200			.027580	.000240			.025607	.000194			
	15, 000	.026987	.000220			.027790	.000210			.025800	.000193			
	20, 000	.027183	.000196			.028000	.000210			.026001	.000201			
	25, 000	.027377	.000194			.028200	.000200			.026200	.000199			
	30, 000	.027603	.000226			.028410	.000210			.026400	.000200			
	35, 000	.027807	.000204			.028650	.000240			.026627	.000227			
	40. 000	.028030	.000223			.028860	.000210			.026853	.000226			
	45, 000	.028247	.000217			.029100	.000240			.027067	.000214			
	50, 000	.028480	.000233			.029340	.000240			.027287	.000220			
	55, 000	.028730	.000250			.029580	.000240			.027533	.000246			
	60, 000	.028983	.000253			.029860	.000280			.027793	.000260			
	65, 000	.029293	.000310	.026533		.030170	.000310	.027300		.028093	.000300	.025380		Micrometer removed.
252, 000	72, 000	.0327	.003087											
259, 000	74, 000	.0367	.0049											
266, 000	76, 000	.0430	.0063											
273, 000	78, 000	.0487	.0057											
280, 000	80, 000	.0583	.0096											
287, 000	82, 000	.0680	.0097											
294, 000	84, 000	.0873	[illegible]											
301, 100	86, 000	.1100	.0227											
305, 100	87, 170													Ultimate strength.
260, 000														Load at time of fracture.

Fracture occurred in that vicinity where the elastic limit of the steel was first reached.
Elongation of 5″ sections after fracture of the bar ″.66, ″.89 (1.78 fractured section), ″.73, ″.65, ″.48.

General summary.

(Section A.)

Tensile strength per square inch of original section	pounds..	87, 170
Elastic limit per square inch of original section	do...	45, 000
Elongation per inch after rupture	inch..	0. 173
Elongation per inch under strain at elastic limit	do...	. 001490
Dimensions at point of rupture, 2".09 by ".88 =	square inch..	1. 839
Reduction in area after rupture, per centum of original section		47. 5
Position of rupture		4" from middle of the bar

Character of broken surface, fine granular, 85 per cent.; radiating from a lozenge-shaped center, 15 per cent., having a dull smoky color.

(Section B.)

Elastic limit per square inch of original section	pounds..	49, 000
Elongation per inch under strain at elastic limit	inch..	0. 001620

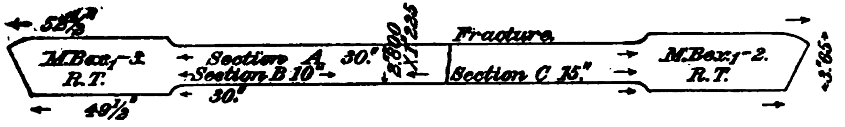
(Section C.)

Elastic limit per square inch of original section	pounds..	47, 000
Elongation per inch under strain at elastic limit	inch..	0. 001560

Measurements showing the cross-section of the bar every 5" in length after it had been strained with 70,000 pounds per square inch and released to the initial load.

Width.	Thickness.		Sectional area.	Contraction of area.	
	Inside edge.	Outside edge.			
Inches.	*Inches.*	*Inches.*	*Sq. inches.*	*Per cent.*	
2. 776	1. 231	1. 234	3. 42	2. 3	End B.
2. 763	1. 231	1. 230	3. 42	2. 9	
2. 765	1. 230	1. 231	3. 40	2. 9	
2. 764	1. 229	1. 231	3. 40	2. 9	
2. 767	1. 232	1. 232	3. 41	2. 6	
2. 772	1. 235	1. 235	3. 42	2. 3	
2. 777	1. 234	1. 234	3. 43	2. 0	End C.

No. 111.



Form of specimen.

Sectional area, 3.43 square inches.

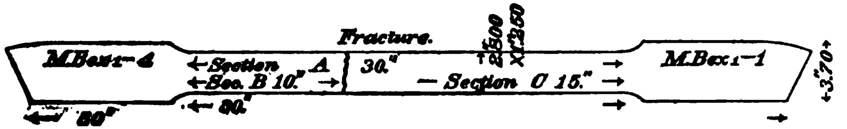
Three micrometers employed for measuring the elongations, placed in the same positions and covering the same lengths as with No. 110.

Applied loads.		Section A.				Section B.				Section C.			Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
3,430	1,000	0.	....	0.	....	0.	....	0.	....	0.	....	0.	
17,150	5,000	.000137	.000137	0.	....	.000140	.000140	0.	....	.000133	.000133	0.	
34,300	10,000	.000320	.000183	0.	....	.000320	.000180	0.	....	.000307	.000174	0.	
51,450	15,000	.000483	.000163	0.	....	.000490	.000170	0.	....	.000467	.000160	0.	
68,600	20,000	.000650	.000167	0.	....	.000670	.000180	0.	....	.000633	.000166	0.	
85,750	25,000	.000820	.000170	.000010	.000010	.000810	.000140	0.	....	.000800	.000167	.000007	
102,900	30,000	.000987	.000167	.000013—	.000003—	.001000	.000190	.000010	.000010	.000967	.000167	.000007+	
120,050	35,000	.001160	.000173	.000017	.000004+	.001160	.000160	.000010	0.	.001133	.000166	.000013	
137,200	40,000	.001337	.000177	.000033	.000016	.001310	.000150	.000020	.000010	.001327	.000194	.000027	Elastic limit, Section A.
138,000	40,230	.004260	.002923	....	....	.001400	.000090	....	....	.007000	.005673	....	Elastic limit, Section C.
139,000	40,520	.005063	.000803	....	....	.001430	.000030	....	....	.008600	.001600	....	
140,000	40,820	.005697	.000634	....	....	.001440	.000010	....	....	.009873	.001273	....	
140,630	41,000	.006873	.001176	.005347	.005314	.001480	.000040	.000090	.000080	.012207	.002334	.010572	
	5,000	.005493	....	....	....	.000240	....	....	....	.010687	....	....	
	10,000	.005667	.000174	....	....	.000400	.000160	....	....	.010873	.000186	....	
	15,000	.005850	.000183	....	....	.000590	.000190	....	....	.011053	.000180	....	
	20,000	.006033	.000183	....	....	.000760	.000170	....	....	.011260	.000207	....	
	25,000	.006217	.000184	....	....	.000920	.000160	....	....	.011460	.000200	....	
	30,000	.006403	.000186	....	....	.001100	.000180	....	....	.011673	.000213	....	
	35,000	.006603	.000200	....	....	.001250	.000150	....	....	.011893	.000220	....	
	40,000	.006850	.000247	....	....	.001420	.000170	....	....	.012200	.000307	....	
141,000	41,110	.006960	....	....	....	.001470	....	....	....	.012380	....	....	

Applied loads.		Section A.				Section B.				Section C.			Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
142, 000	41, 400	.007057				.001490				.012533			
143, 000	41, 690	This load was sustained about three minutes, while stretching started in Section B and went on gradually. At the end of three minutes the load suddenly fell to 134,000 pounds, while the metal in Section B rapidly elongated. The elongations now taken with reduced loads, show how the metal continued to stretch under loads below that which it had previously sustained.											Elastic limit, Section B.
134, 000	39, 070	.007733				.003100				.012680			
135, 000	39, 360	.007903				.003590				.012680			
136, 000	39, 650	.008030				.003990				.012673			
137, 000	39, 940	.008073				.004100				.012673			
138, 000	40, 230	.008133				.004250				.012673			
139, 000	40, 520	.008170				.004340				.012673			
140, 000	40, 820	.008213				.004450				.012693			
141, 000	41, 110	.008283				.004620				.012707			
142, 000	41, 400	.008397				.004900				.012747			
143, 000	41, 690	.008467				.005010				.012793			
144, 060	42, 000	.008597		.007000		.005200		.003680		.012920		.011253	
	5, 000	.007137				.003800				.011867			
	10, 000	.007320	.000183			.004000	.000200			.011546	.000179		
	15, 000	.007500	.000180			.004160	.000160			.011740	.000194		
	20, 000	.007683	.000183			.004330	.000170			.011933	.000193		
	25, 000	.007870	.000187			.004510	.000180			.012133	.000200		
	30, 000	.008063	.000193			.004700	.000190			.012340	.000207		
	35, 000	.008273	.000210			.004900	.000200			.012553	.000213		
	40, 000	.008500	.000227			.005100	.000200			.012800	.000247		
145, 000	42, 270	.008757				.005300				.013133			
146, 000	42, 560	.008833				.005380				.013247			
147, 000	42, 850	.009033				.005560				.013520			
147, 490	43, 000	.009193				.005650				.013733			
148, 000	43, 140	.009333				.005750				.013933			
149, 000	43, 430	.009523				.005900				.014173			
150, 000	43, 730	.009880				.006130				.014613			
150, 920	44, 000	.010080				.006270				.014867			
154, 350	45, 000	Load again fell, while metal in section B rapidly elongated.											
148, 000	43, 140	.012817				.007980				.015780			
149, 000	43, 430	.014150				.011620				.015860			
150, 000	43, 730	.014767				.013320				.015933			
151, 000	44, 010	.014800				.013400				.015933			
152, 000	44, 310	.014837				.013460				.015960			
153, 000	44, 600	.014887				.013510				.016000			
154, 350	45, 000	.014977		.013073		.013680		.011760		.016033		.014200	Bar rested 15 hours under initial load. Sets measured after 15 hours' rest.
....	....	....		.013063		....		.011740		....		.014187	
	5, 000	.013200				.011890				.014280			
	10, 000	.013380	.000180			.012070	.000180			.014407	.000187		

No. 110.

Form of specimen.



Sectional area, 3.50 square inches.

Three micrometers used for measuring the elongations. The micrometer on section A covers the whole length of stem of specimen, 30 inches along the center line of the bar. The micrometer on section B covers 10 inches length, and that on section C covers 15 inches length.

Sections B and C are taken along the same side of the bar, and .20 inch from the edge.

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
3, 500	1, 000	0.	....	0.	....	0.	....	0.	....	0.	....	0.	....	Initial load.
17, 500	5, 000	.000133	.000133	0.	....	.000130	.000130	0.	....	.000127	.000127	0.	....	
35, 000	10, 000	.000327	.000194	0.	....	.000330	.000200	0.	....	.000293	.000166	0.	....	
52, 500	15, 000	.000487	.000160	0.	....	.000480	.000150	0.	....	.000460	.000167	0.	....	
70, 000	20, 000	.000647	.000160	0.	....	.000660	.000180	0.	....	.000633	.000173	0.	....	
87, 500	25, 000	.000817	.000170	0.	....	.000810	.000150	0.	....	.000793	.000160	0.	....	
105, 000	30, 000	.000977	.000160	0.	....	.000990	.000180	0.	....	.000960	.000167	0.	....	
122, 500	35, 000	.001140	.000163	0.	....	.001170	.000180	0.	....	.001120	.000160	0.	....	
140, 000	40, 000	.001313	.000173	0.	....	.001320	.000150	0.	....	.001280	.000160	0.	....	
143, 500	41, 000	.001343	.000030	....	....	.001360	.000040	....	....	.001327	.000047	....	....	
147, 000	42, 000	.001380	.000037	....	....	.001410	.000050	....	....	.001353	.000026	....	....	
150, 500	43, 000	.001417	.000037	....	....	.001430	.000020	....	....	.001393	.000040	....	....	
154, 000	44, 000	.001453	.000036	....	....	.001470	.000040	....	....	.001433	.000040	....	....	
157, 500	45, 000	.001490	.000037	.000017	.000017	.001510	.000040	0.	....	.001467	.000034	.000013	.000013	Elastic limit, sec. A.
161, 000	46, 000	.001533	.000043	....	....	.001540	.000030	....	....	.001513	.000046	....	....	
164, 500	47, 000	.001580	.000047	.000037	.000020	.001590	.000050	.000010	.000010	.001560	.000047	.000053	.000040	Elastic limit, sec. C.
168, 000	48, 000	.001637	.000057	....	....	.001620	.000030	....	....	.001620	.000060	....	....	
171, 500	49, 000	.002750	.001113	....	....	.001620	0.	....	....	.002067	.000447	....	....	Elastic limit, sec. B.

General summary.

(Section A.)

Tensile strength per square inch of original section	pounds..	76,000
Elastic limit per square inch of original section	do...	40,000
Elongation per inch after rupture	inch..	0.156
Elongation per inch under strain at elastic limit	do...	0.001337
Dimensions at point of rupture, 2".04 by ".85=	square inch..	1.734
Reduction in area after rupture, per cent. of original section		49.4
Position of rupture		4" from middle of bar

Character of broken surface: fine silky, 33 per cent.; granular, 67 per cent., radiating from silky portion.

(Section B.)

Elastic limit per square inch of original section	pounds..	41,400
Elongation per inch under strain at elastic limit	inch..	0.001490

(Section C.)

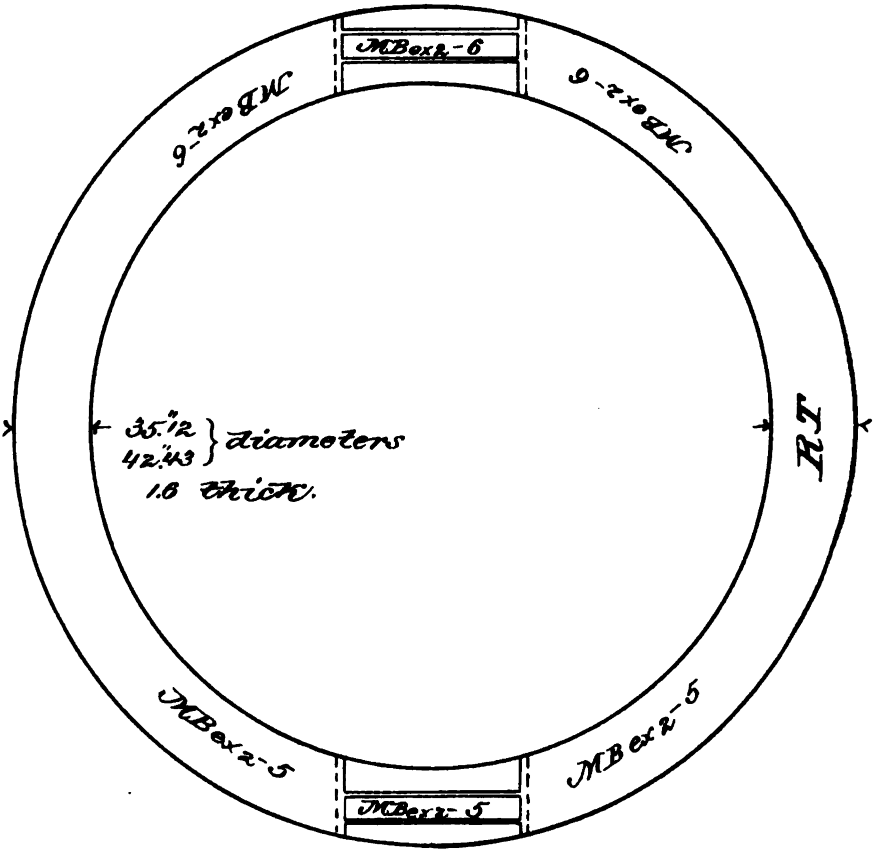
Elastic limit per square inch of original section	pounds..	40,000
Elongation per inch under strain at elastic limit	inch..	0.001327

Measurements showing the cross-section of the bar every 5" in length after it had been strained with 60,000 pounds per square inch, and released to the initial load.

Width.	Thickness.		Sectional area.	Contraction of area.	
	Inside edge.	Outside edge.			
Inches.	*Inches.*	*Inches.*	*Sq. inch.*	*Per cent.*	
2.762	1.200	1.195	3.31	3.5	End B.
2.760	1.207	1.207	3.33	2.9	
2.759	1.207	1.206	3.33	2.9	
2.751	1.202	1.203	3.31	3.5	
2.747	1.201	1.200	3.30	3.8	
2.752	1.203	1.202	3.31	3.5	
2.758	1.197	1.197	3.30	3.8	End C.

2nd ring from Hoop Bex
12 inch Mortar

Rolled



No. 108.

Tension test.

Marks on bar, M. B_{xx2}—5.
Length, 6″.
Diameter, .″564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	Initial load.
1,250	5,000	.000117	.000117	—.000017.	—.000017	
2,500	10,000	.000267	.000150	—.000017	0.	
3,750	15,000	.000417	.000150	—.000017	0.	
5,000	20,000	.000550	.000133	—.000017	0.	
6,250	25,000	.000683	.000133	—.000017	0.	
7,500	30,000	.000850	.000167	—.000017	0.	
8,750	35,000	.001000	.000150	0.	.000017	
10,000	40,000	.001167	.000167	0.	0.	
11,250	45,000	.001333	.000166	....	....	
11,500	46,000	.001383	.000050	....	....	
11,750	47,000	.001433	.000050	....	....	
12,000	48,000	.001500	.000067	....	....	
12,250	49,000	.001517	.000017	....	....	
12,500	50,000	.001567	.000050	.000100	.000100	Elastic limit.
12,750	51,000	.001750	.000183	....	....	
13,000	52,000	.003333	.001583	....	....	
13,250	53,000	.003817	.000524	....	....	
13,500	54,000	.004533	.000716	....	....	
13,750	55,000	.004983	.000450	.003033	.002933	
14,000	56,000	.005550	.000567	....	....	
14,250	57,000	.006083	.000533	....	....	
14,500	58,000	.007017	.000934	....	....	
14,750	59,000	.007483	.000466	....	....	
15,000	60,000	.008650	.001167	.006333	.003300	
15,250	61,000	.009233	.000583	....	....	
15,500	62,000	.009467	.000234	....	....	
15,750	63,000	.010233	.000766	....	....	
16,000	64,000	.011317	.001084	....	....	
16,250	65,000	.011867	.000550	.009367	.003034	
16,500	66,000	.012683	.000816	....	....	
16,750	67,000	.013317	.000634	....	....	
17,000	68,000	.014600	.001283	....	....	
17,250	69,000	.015083	.000483	....	....	
17,500	70,000	.016133	.001050	.018283	.008916	
18,000	72,000	.017933	.001800	....	....	
18,500	74,000	.020100	.002167	....	....	
19,000	76,000	.021983	.001883	....	....	
19,500	78,000	.024283	.002300	....	....	
20,000	80,000	.026750	.002467	.023333	.010050	Micrometer removed.
20,500	82,000	.0283	.001550	....	....	
21,000	84,000	.0317	.0034	....	....	
21,500	86,000	.0350	.0033	....	....	
22,000	88,000	.0383	.0033	....	....	
22,500	90,000	.0433	.0050	....	....	
23,000	92,000	.0467	.0034	....	....	
23,500	94,000	.0533	.0066	....	....	
24,000	96,000	.0617	.0084	....	....	
24,500	98,000	.0717	.0100	....	....	
25,000	100,000	.0850	.0133	....	....	
25,500	102,000	.1167	.0317	....	....	Ultimate strength.
23,000	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds	102,000
Elastic limit per square inch of original section	do	50,000
Elongation per inch after rupture	inch	0.178
Elongation per inch under strain at elastic limit	do	.001567
Reduction in diameter at point of rupture		.114
Reduction in area after rupture, per centum of original section		36.4
Position of rupture		1⅓″ from neck
Character of broken surface		granular, radiating from smoky spot at center.

No. 109.

Tension test.

Marks on bar, M. $B_{EX\,I}$—6.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

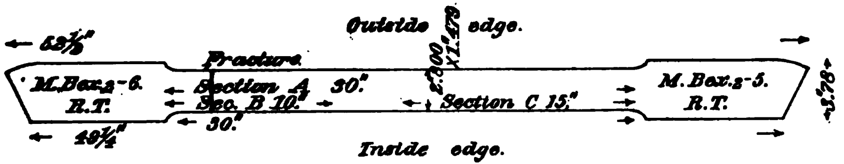
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	....	....	
1,250	5,000	.000083	.000033	....	....	
2,500	10,000	.000183	.000150	— .000017	— .000017	
3,750	15,000	.000333	.000150	— .000017	0.	
5,000	20,000	.000450	.000117	— .000033	— .000016	
6,250	25,000	.000583	.000133	— .000033	0.	
7,500	30,000	.000750	.000167	— .000033	0.	
8,750	35,000	.000916	.000166	— .000050	— .000017	
10,000	40,000	.001100	.000184	— .000050	0.	
11,250	45,000	.001250	.000150	— .000050	0.	
12,500	50,000	.001467	.000217	0.	.000050	Elastic limit.
12,750	51,000	.001550	.000083	....	....	
13,000	52,000	.001683	.000133	....	....	
13,250	53,000	.001883	.000200	....	....	
13,500	54,000	.002733	.000850	....	....	
13,750	55,000	.003233	.000500	.001383	.001383	
14,000	56,000	.003783	.000500	....	....	
14,250	57.000	.004233	.000500	....	....	
14,500	58,000	.004900	.000667	....	....	
14,750	59,000	.005467	.000567	....	....	
15,000	60,000	.006283	.000816	.004100	.002717	
15,250	61,000	.006833	.000550	....	....	
15,500	62,000	.007533	.000700	....	....	
15,750	63,000	.008100	.000567	....	....	
16,000	64,000	.009067	.000967	....	....	
16,250	65,000	.009433	.000366	.006917	.002817	
16,500	66,000	.010317	.000884	....	....	
16,750	67,000	.010867	.000550	....	....	
17,000	68,000	.011817	.000950	....	....	
17,250	69,000	.012550	.000783	....	....	
17,500	70,000	.013350	.000800	.010517	.003600	
18,000	72,000	.015067	.001717	....	....	
18,500	74,000	.016933	.001866	....	....	
19,000	76,000	.018900	.001967	....	....	
19,500	78,000	.020983	.002083	....	....	
20,000	80.000	.022983	.002000	.019567	.009050	Micrometer removed.
20,500	82,000	.0250	.002017	....	....	
21,000	84,000	.0283	.0033	....	....	
21,500	86,000	.0317	.0034	....	....	
22,000	88,000	.0350	.0033	....	....	
22,500	90,000	.0367	.0017	....	....	
23,000	92,000	.0417	.0050	....	....	
23,500	94,000	.0450	.0033	....	....	
24,000	96,000	.0500	.0050	....	....	
24,500	98,000	.0550	.0050	....	....	
25,000	100,000	.0650	.0100	....	....	
25,500	102,000	.0767	.0117	....	....	
26,000	104,000	.0983	.0216	....	....	
26,300	105,200	.1233	.0250	....	....	Ultimate strength.
23,860	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	105,200
Elastic limit per square inch of original section	do....	50,000
Elongation per inch after rupture	inch..	0.167
Elongation per inch under strain at elastic limit	do....	.001467
Reduction in diameter at point of rupture	do....	.114
Reduction in area after rupture, per centum of original section		36.4
Position of rupture		1″.2 from neck.
Character of broken surface		granular, radiating from smoky spot at center.

No. 112.

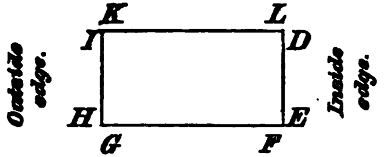
Form of specimen.



Sectional area, 4.14 square inches.

Three micrometers employed to determine the elongations, placed in the same positions and covering the same lengths as with No. 110.

Cross-section of stem of bar, showing the lettering of lines along which ordinates were measured, after having been strained with 46,000 pounds per square inch.



Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
4,140	1,000	0.	....	0.	....	0.	....	0.	....	0.	....	0.	....	
20,700	5,000	.000130	.000130	0.	....	.000120	.000120	0.	....	.000093	.000093	0.	....	
41,400	10,000	.000300	.000170	0.	....	.000290	.000170	0.	....	.000253	.000160	0.	....	
62,100	15,000	.000463	.000168	0.	....	.000460	.000170	0.	....	.000413	.000160	0.	....	
82,800	20,000	.000637	.000174	0.	....	.000650	.000190	0.	....	.000600	.000187	0.	....	

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
103, 500	25, 000	.000803	.000166	.000017	.000017	.000800	.000150	.000000+	.000000+	.000760	.000160	.000020	....	
107, 640	26, 000	.000840	.000037	....	....	.000840	.000040	....	....	.000800	.000140	....	....	
111, 780	27, 000	.000870	.000030	....	....	.000880	.000040	....	....	.000827	.000027	....	....	
115, 920	28, 000	.000903	.000033	....	....	.000910	.000030	....	....	.000867	.000040	....	....	
120, 060	29, 000	.000937	.000034	....	....	.000950	.000040	....	....	.000920	.000053	....	....	
124, 200	30, 000	.000980	.000043	.000023	.000006	.000980	.000030	.000010	.000010−	.000933	.000013	.000047	....	Rested under initial load 15 hours.
....	....	....	....	.000017	....	....	....	.000010	....	....	....	.000040+	....	Sets measured after 15 hours rest.
128, 340	31, 000	.001007	.000027	....	....	.001010	.000030	....	....	.000993	.000060	....	....	
132, 480	32, 000	.001043	.000036	....	....	.001040	.000030	....	....	.001013	.000020	....	....	
136, 620	33, 000	.001080	.000037	....	....	.001070	.000030	....	....	.001060	.000047	....	....	
140, 760	34, 000	.001117	.000037	....	....	.001100	.000030	....	....	.001100	.000040	....	....	
144, 900	35, 000	.001153	.000036	.000027	.000004	.001150	.000050	.000000−	.000010	.001127	.000027	.000067	.000020	
149, 040	36, 000	.001187	.000034	....	....	.001180	.000030	....	....	.001167	.000040	....	....	
153, 180	37, 000	.001223	.000036	....	....	.001210	.000030	....	....	.001200	.000033	....	....	
157, 320	38, 000	.001260	.000037	.000030	.000003	.001250	.000040	.000000	0.	.001247	.000047	.000067	0.	
161, 460	39, 000	.001293	.000033	....	....	.001290	.000040	....	....	.001273	.000026	....	....	
165, 600	40, 000	.001333	.000040	.000033	.000003	.001320	.000030	.000000	0.	.001320	.000047	.000073	.000006	
169, 740	41, 000	.001370	.000037	....	....	.001370	.000050	....	....	.001347	.000027	....	....	Elastic limit, section A.
173, 880	42, 000	.001430	.000060	....	....	.001430	.000060	....	....	.001393	.000046	....	....	Elastic limit, section B.
When the load on the bar reached 42,000 pounds per square inch with the elongations above shown, rapid stretching took place in section B, the load falling to 38,526 pounds per square inch. The elongations now taken, with reduced loads, show how the metal of the bar continued to stretch under loads below that which it had previously sustained.														
159, 500	38, 526	.001663	....	....	....	.002420	....	....	....	.001298	....	....	....	
160, 000	38, 650	.001697	....	....	....	.002510	....	....	....	.001287	....	....	....	
161, 000	38, 890	.001737	....	....	....	.002620	....	....	....	.001280	....	....	....	
161, 400	39, 000	.001773	....	....	....	.002730	....	....	....	.001280	....	....	....	
162, 000	39, 130	.001803	....	.000503	....	.002840	....	.001470	....	.001273	....	.000060	....	
163, 000	39, 370	.001837	....	....	....	.002910	....	....	....	.001280	....	....	....	
164, 000	39, 620	.001870	....	....	....	.002990	....	....	....	.001280	....	....	....	
165, 000	39, 860	.001960	....	....	....	.003190	....	....	....	.001293	....	....	....	
165, 600	40, 000	.002010	....	.000687	....	.003310	....	.001930	....	.001300	....	.000058	....	
166, 000	40, 100	.002040	....	....	....	.003420	....	....	....	.001820	....	....	....	
The bar examined with a straight edge, and found concave ".005± along the inside edge of the hoop.														
167, 000	40, 340	.002038	....	....	....	.003500	....	....	....	.001327	....	....	....	
168, 000	40, 580	.002140	....	....	....	.003680	....	....	....	.001327	....	....	....	
169, 000	40, 820	.002230	....	....	....	.003880	....	....	....	.001333	....	....	....	
169, 700	41, 000	.002283	....	....	....	.004020	....	....	....	.001347	....	....	....	
173, 880	42, 000	.002583	....	....	....	.004870	....	....	....	.001418	....	....	....	Elastic limit, section C.
178, 020	43, 000	.002900	....	....	....	.004910	....	....	....	.002047	....	....	....	

When the load on the bar reached 43,000 pounds per square inch, with the elongations above shown, rapid stretching took place in section C, while the load fell to 40,100 pounds per square inch. Observations were made as before, showing the effect now of reduced loads on the stretch of the bar.

166,000	40,100	.002970				.004870				.002220			
167,000	40,340	.004140				.004880				.004513			

The bar again examined with a straight edge, and found concave along the inside edge at end B, whereas at end C the bar is now convex ".01 ± in 12" length.

168,000	40,580	.004310				.004880				.004853			
169,740	41,000	.004513				.004900				.005207			
173,880	42,000	.004983				.004940				.006073			
178,020	43,000	.005557				.005270				.007040			
182,160	44,000	.006133				.005940				.007767			
186,300	45,000	.007000		.005327		.006880		.005190		.008860		.007160	
190,440	46,000	.008007				.009080				.009293			

Falling off of the load again takes place, accompanied by an increase in the rate of stretch in section B.

179,000	43,230	.008057				.009400				.009267			
180,000	43,480	.009070				.012380				.009247			

Falling off of the load sustained by the bar again takes place, accompanied by further elongation in section B.

176,000	42,510	.009103				.012550				.009233			
177,000	42,750	.009123				.012580				.009227			
178,000	42,990	.009230				.012720				.009233			
179,000	43,230	.009907				.013200				.009247			
180,000	43,480	.010467				.013340				.009253			
181,000	43,720	.010700		.008983		.013430		.011570		.009247		.007600	

Sectional areas and ordinates now measured every 5 inches along the length of the bar. The lines along which the ordinates were measured are shown by lettering on sketch of cross-section of bar on first page of the test. The sectional areas and ordinates are recorded in table at the end of the test.

Test resumed after a rest of four hours, the bar during the rest being under no load.

182,160	44,000	.010933				.013550				.009300				
186,300	45,000	.011503				.013760				.009633				
190,440	46,000	.014733		.012800		.014670		.012700		.014747		.012938		
	5,000	.012933				.012830				.013000				
	10,000	.013130	.000197			.013050	.000220			.013173	.000173			
	15,000	.013320	.000190			.013220	.000170			.013360	.000187			
	20,000	.013513	.000193			.013420	.000200			.013540	.000180			
	25,000	.013710	.000197			.013640	.000220			.013740	.000200			
	30,000	.013927	.000217			.013860	.000220			.013940	.000200			
	35,000	.014143	.000216			.014080	.000220			.014167	.000227			
	40,000	.014383	.000240	.012813		.014300	.000220	.012710		.014387	.000220	.012913		Rested under initial load 40 hours.
				.012287				.012700				.012880		Sets measured after 40 hours' rest.
	5,000	.012930				.012840				.012967				
	10,000	.013107				.013010				.013133				
	15,000	.013293				.013190				.013320				
	20,000	.013490				.013400				.013500				
	25,000	.013697				.013600				.013700				
	30,000	.013903				.013830				.013907				
	35,000	.014127				.014050				.014120				
	40,000	.014353		.012803		.014280		.012700		.014347		.012893		
194,580	47,000	.015130				.015000				.014693				
198,720	48,000	.015737				.015600				.015700				
202,860	49,000	.017053				.016880				.017087				

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
207,000	50,000	.018193		.016033		.018200		.016060		.018340		.016267		
211,140	51,000	.018887				.018950				.019067				
215,280	52,000	.019893				.020120				.020073				
219,420	53,000	.021257				.021620				.021460				
223,560	54,000	.022183				.022600				.022407				
227,700	55,000	.023767		.021310		.024250		.021800		.023967		.021620		
231,840	56,000	.025037				.025580				.025253				
235,980	57,000	.026467				.027050				.026647				
240,120	58,000	.027930				.028580				.028093				
244,260	59,000	.029460				.030120				.029600				
248,400	60,000	.031250		.028490		.031890		.029260		.031400		.028733		
	5,000	.028597				.029360				.028780				
	10,000	.028817	.000220			.029590	.000230			.028987	.000207			
	15,000	.029017	.000200			.029790	.000200			.029193	.000206			
	20,000	.029223	.000206			.029980	.000190			.029400	.000207			
	25,000	.029437	.000214			.030170	.000190			.029600	.000200			
	30,000	.029667	.000230			.030360	.000190			.029813	.000213			
	35,000	.029883	.000216			.030540	.000180			.030047	.000234			
	40,000	.030113	.000230			.030770	.000230			.030267	.000220			
	45,000	.030363	.000250			.031000	.000230			.030513	.000346			
	50,000	.030617	.000254	.028507		.031280	.005280	.029180		.030780	.000267	.028740		
256,680	62,000	.0353												Micrometers removed.
264,960	64,000	.0397												
273,240	66,000	.0427												
281,520	68,000	.0480												
289,800	70,000	.0540												
298,080	72,000	.0597												
306,360	74,000	.0707												
314,640	76,000	.0807												
322,920	78,000	.0933												
327,800	79,180	.1080												Ultimate strength.
278,500														Load at time of fracture.

Under the higher loads the stretch of the metal was irregular in different sections, making itself manifest by convexing the sides of the bar at different places along its length. The position of the point of maximum convexity was observed to change as the loads advanced.

General summary.

(Section A.)

Tensile strength per square inch of original section	pounds..	79,180
Elastic limit per square inch of original section	do....	41,000
Elongation per inch after rupture	inch..	0.142
Elongation per inch under strain at elastic limit	do....	.001870
Dimensions at point of rupture, 2″.06x1″.02=	square inches..	2.10
Reduction in area after rupture, per centum of original section		49.3
Position of rupture		.2 inches from end M. Br. x. 2—6
Character of broken surface		Silky at the center, gradually changing to granular at the edges. The granular metal radiates from the center of the bar.

(Section B.)

Elastic limit per square inch of original section	pounds..	42.000
Elongation per inch under strain at elastic limit	inch..	0.001430

(Section C.)

Elastic limit per square inch of original section	pounds..	42.000
Elongation per inch under strain at elastic limit	inch..	0.001413

Sectional areas and ordinates measured every 5 inches along the length of the bar, after it had been strained with 46,000 pounds per square inch and released to zero load.

AREAS.

End areas taken ½ inch from curve of necks.

Width.	Thickness.		Sectional area.	Contraction of area.	
	Indside edge.	Outside edge.			
Inches.	*Inch.*	*Inch.*	*Sq. Inches.*	*Per cent.*	
2.782	1.467	1.467	4.08	1.4	End M. Br. x. 2—6.
2.786	1.472	1.472	4.10	1.0	
2.788	1.471	1.471	4.10	1.0	
2.801	1.476	1.478	4.14	0.0	
2.795	1.472	1.477	4.12	0.5	
2.786	1.472	1.470	4.10	1.0	
2.784	1.471	1.472	4.10	1.0	End M. Br. x. 2—5.

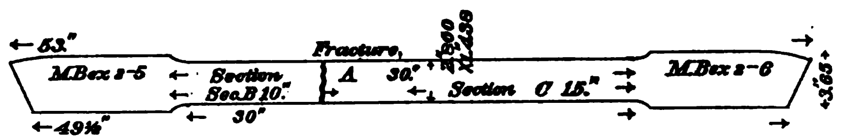
ORDINATES.

Base line parallel to edge of bar, beginning ¼ inch from neck at each end. Plus readings indicate convexity, minus readings concavity.

		Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
Line D	0	+.0010	+.0134	+.0358	+.0280	+.0050	0
Line E	0	—.0010	+.0120	+.0337	+.0250	+.0026	0
Line F	0	+.0100	+.0075	+.0084	+.0069	+.0040	0
Line G	0	+.0084	+.0060	+.0072	+.0074	+.0008	0
Line H	0	—.0025	—.0122	—.0185	—.0180	—.0050	0
Line I	0	+.0050	—.0046	—.0130	—.0124	—.0012	0
Line K	0	—.0040	—.0011	+.0050	+.0016	—.0009	0
Line L	0	—.0048	—.0008	+.0050	0	0	0

No. 113.

Form of specimen.



Sectional area, 4.03 square inches.

Three micrometers employed to determine the elongations, placed in the same positions, and covering the same lengths as with No. 110.

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
4,030	1,000	0.	....	0.	....	0.	....	0.	....	0.	....	0.	....	Initial load.
20,150	5,000	.000130	.000130	0.	....	.000140	.000140	0.	....	.000100	.000100	0.	....	
40,300	10,000	.000300	.000170	.000010	.000010	.000300	.000160	.000000+	.000000+	.000267	.000167	.000013	.000018	
60,450	15,000	.000460	.000160	.000010	0.	.000470	.000170	.000010	.000010—	.000440	.000173	.000020	.000007	
80,600	20,000	.000627	.000167	.000010+	.000000+	.000650	.000180	.000010	0.	.000600	.000160	.000020	0.	
100,750	25,000	.000783	.000156	.000017	.000007—	.000800	.000150	.000010	0.	.000773	.000173	.000020	0.	
120,900	30,000	.000950	.000167	.000020	.000003	.000980	.000180	.000020	.000010	.000940	.000167	....	....	
124,930	31,000	.000993	.000043	....	....	.001010	.000030	....	....	.000967	.000027	....	....	
128,960	32,000	.001027	.000034	....	....	.001040	.000030	....	....	.000993	.000026	....	....	
132,990	33,000	.001063	.000036	....	....	.001080	.000040	....	....	.001033	.000040	....	....	
137,020	34,000	.001093	.000030	....	....	.001110	.000030	....	....	.001067	.000034	....	....	
141,050	35,000	.001130	.000037	.000017	—.000008	.001180	.000020	.000010	—.000010	.001100	.000033	.000020	0.	
145,080	36,000	.001160	.000030	....	....	.001180	.000050	....	....	.001133	.000033	....	....	
149,110	37,000	.001197	.000037	....	....	.001210	.000030	....	....	.001173	.000040	....	....	
153,140	38,000	.001227	.000030	....	....	.001240	.000030	....	....	.001200	.000027	....	....	
157,170	39,000	.001267	.000040	....	....	.001280	.000040	....	....	.001247	.000047	....	....	
161,200	40,000	.001300	.000033	.000003	—.000014	.001300	.000020	0.	—.000010	.001273	.000026	.000007	—.000013	
165,230	41,000	.001333	.000033	....	....	.001340	.000040	....	....	.001320	.000047	....	....	

169, 260	42, 000	.001363	.000080	....	....	.001400	.000060	....	....	.001347	.000027	....	....	
173, 290	43, 000	.001400	.000037	....	....	.001430	.000030	....	....	.001387	.000040	....	....	
177, 320	44, 000	.001443	.000043	....	....	.001470	.000040	....	....	.001420	.000033	....	....	
181, 350	45, 000	.001480	.000037	.000020	.000017	.001510	.000040	.000020	.000020	.001453	.000033	.000027	.000020	
185, 380	46, 000	.001527	.000047	....	....	.001560	.000050	....	....	.001500	.000047	....	....	
189, 410	47, 000	.001563	.000036	....	....	.001600	.000040	....	....	.001533	.000033	....	....	Elastic limit, Section A.
193, 440	48, 000	.001617	.000054	.000050	.000030	.001670	.000070	.000080	.000060	.001580	.000047	.000047	.000020	
197, 470	49, 000	.001677	.000060	....	....	.001750	.000080	....	....	.001627	.000047	....	....	
201, 500	50, 000	.001740	.000063	.000103	.000053	.001810	.000060	.000140	.000060	.001680	.000053	.000073	.000026	Elastic limit, sections B and C.
205, 530	51, 000	.001867	.000127	....	....	.001990	.000180	....	....	.001767	.000067	....	....	
209, 560	52, 000	.003360	.001493	....	....	.004680	.002690	....	....	.001967	.000200	....	....	
213, 590	53, 000	.005160	.001800	....	....	.005980	.001300	....	....	.004327	.002360	....	....	
217, 620	54, 000	.006280	.001120	....	....	.006970	.000990	....	....	.005587	.001260	....	....	
221, 650	55, 000	.007103	.000823	.004963	.004860	.007740	.000770	.005570	.005430	.006413	.000826	.004373	.004300	
225, 680	56, 000	.007913	.000810	....	....	.008550	.000810	....	....	.007233	.000820	....	....	
229, 710	57, 000	.008770	.000857	....	....	.009390	.000840	....	....	.008073	.000840	....	....	
233, 740	58, 000	.009600	.000830	....	....	.010240	.000850	....	....	.008893	.000820	....	....	
237, 770	59, 000	.010677	.001077	....	....	.011340	.001100	....	....	.009953	.001060	....	....	
241, 800	60, 000	.011673	.000996	.009193	.004230	.012270	.000930	.009810	.004240	.010920	.000967	.008547	.004174	
245, 830	61, 000	.012270	.000597	....	....	.012980	.000710	....	....	.011527	.000607	....	....	
249, 860	62, 000	.013270	.001000	....	....	.013980	.001000	....	....	.012473	.000946	....	....	
253, 890	63, 000	.014270	.001000	....	....	.015070	.001090	....	....	.013447	.000974	....	....	
257, 920	64, 000	.015017	.000747	....	....	.016120	.001050	....	....	.014447	.001000	....	....	
261, 950	65, 000	.016483	.001466	.013683	.004490	.017380	.001260	.014500	.004690	.015600	.001153	.012913	.004366	
265, 980	66, 000	.017310	.000827	....	....	.018210	.000830	....	....	.016400	.000800	....	....	
270, 010	67, 000	.018130	.000820	....	....	.019050	.000840	....	....	.017200	.000800	....	....	
274, 040	68, 000	.019350	.001220	....	....	.020300	.001250	....	....	.018367	.001167	....	....	
278, 070	69, 000	.020763	.001413	....	....	.021850	.001550	....	....	.019753	.001386	....	....	
282, 100	70, 000	.021917	.001154	.018850	.005167	.023100	.001250	.019970	.005470	.020873	.001120	.017907	.004994	Rested under initial load 15 hours.
....	....	....	....	.018833	....	....	....	.019970	....	....	....	.017880	....	Sets measured after 15 hours rest.
	5, 000	.018983	....	....	....	.020110	....	....	....	.017953	....	....	....	
	10, 000	.019170	.000187	....	....	.020300	.000190	....	....	.018133	.000180	....	....	
	15, 000	.019367	.000197	....	....	.020510	.000210	....	....	.018327	.000194	....	....	
	20, 000	.019560	.000193	....	....	.020700	.000190	....	....	.018527	.000200	....	....	
	25, 000	.019760	.000200	....	....	.020900	.000200	....	....	.018720	.000193	....	....	
	30, 000	.019957	.000197	....	....	.021100	.000200	....	....	.018920	.000200	....	....	
	35, 000	.020163	.000206	....	....	.021310	.000210	....	....	.019127	.000207	....	....	
	40, 000	.020373	.000210	....	....	.021550	.000240	....	....	.019333	.000206	....	....	
	45, 600	.020593	.000220	....	....	.021760	.000210	....	....	.019540	.000207	....	....	
	50, 000	.020817	.000224	....	....	.021980	.000220	....	....	.019773	.000233	....	....	
	55, 000	.021050	.000233	....	....	.022220	.000240	....	....	.020000	.000227	....	....	
	60, 000	.021310	.000260	.018890	....	.022500	.000280	.020010	....	.020253	.000253	.017933	....	
	5, 000	.019033	....	....	....	.020180	....	....	....	.018000	....	....	....	
	10, 000	.019223	.000190	....	....	.020360	.000180	....	....	.018193	.000193	....	....	
	15, 000	.019413	.000190	....	....	.020570	.000210	....	....	.018373	.000180	....	....	
	20, 000	.019600	.000187	....	....	.020750	.000180	....	....	.018567	.000194	....	....	
	25, 000	.019800	.000200	....	....	.020960	.000210	....	....	.018767	.000200	....	....	
	30, 000	.020003	.000203	....	....	.021150	.000190	....	....	.018960	.000193	....	....	
	35, 000	.020203	.000200	....	....	.021370	.000220	....	....	.019160	.000200	....	....	

Applied loads.		Section A.				Section B.				Section C.				Remarks.
Total.	Per square inch.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
	40, 000	.020413	.000210	....	....	.021580	.000210	....	....	.019360	.000200	....	....	
	45, 000	.020617	.000204	....	....	.021790	.000210	....	....	.019580	.000220	....	....	
	50, 000	.020833	.000216	....	....	.022000	.000210	....	....	.019800	.000220	....	....	
	55, 000	.021060	.000227	....	....	.022280	.000230	....	....	.020007	.000207	....	....	
	60, 000	.021290	.000230	.018900	....	.022490	.000260	.020010	....	.020240	.000233	.017933	....	Micrometers removed.
290, 160	72, 000	.0250	....	....	....	....	....	....	....	....	....	....	....	
298, 220	74, 000	.0277	....	....	....	....	....	....	....	....	....	....	....	
306, 280	76, 000	.0310	....	....	....	....	....	....	....	....	....	....	....	
314, 340	78, 000	.0343	....	....	....	....	....	....	....	....	....	....	....	
322, 400	80, 000	.0383	....	....	....	....	....	....	....	....	....	....	....	
330, 460	82, 000	.0427	....	....	....	....	....	....	....	....	....	....	....	
338, 520	84, 000	.0507	....	....	....	....	....	....	....	....	....	....	....	
346, 580	86, 000	.0600	....	....	....	....	....	....	....	....	....	....	....	
354, 640	88, 000	.0710	....	....	....	....	....	....	....	....	....	....	....	
362, 700	90, 000	.0870	....	....	....	....	....	....	....	....	....	....	....	
363, 600	90, 220	.0917	....	....	....	....	....	....	....	....	....	....	....	
364, 000	90, 320	.1003	....	....	....	....	....	....	....	....	....	....	....	
365, 000	90, 570	.1070	....	....	....	....	....	....	....	....	....	....	....	
366, 000	90, 820	.1103 .1143	....	....	....	....	....	....	....	....	....	....	....	
367, 000	91, 070	.1200 .1307	....	....	....	....	....	....	....	....	....	....	....	Ultimate strength.
325, 400	....	....	....	....	....	....	....	....	....	....	....	....	....	Load at time of fracture.

Elongation of 5-inch sections: ″.75 (1.80 fractured section), ″.92, ″.70, ″.44, ″.35.

The behavior of this bar when the maximum load was nearly reached was similar to that of the retempered bars, Nos. 111 and 112, in the vicinity of their elastic limit, *i. e.*, the bar would show a falling off of the load sustained during the time the metal continued to stretch.

General summary.

(Section A.)

Tensile strength per square inch of original section	pounds..	91, 070
Elastic limit per square inch of original section	do ..	47, 000
Elongation per inch after rupture	inch..	.165
Elongation per inch under strain at elastic limit	do...	.001563
Dimensions at point of rupture, 2″.15×1″.08	square inch..	2. 322
Reduction in area after rupture, per centum of original section	...	42. 4
Position of rupture		9″ from neck at end M. B.$_{12}$ —5
Character of broken surface		granular, radiating from a dull smoky spot ″.40 in diameter at the center of the bar.

(Section B.)

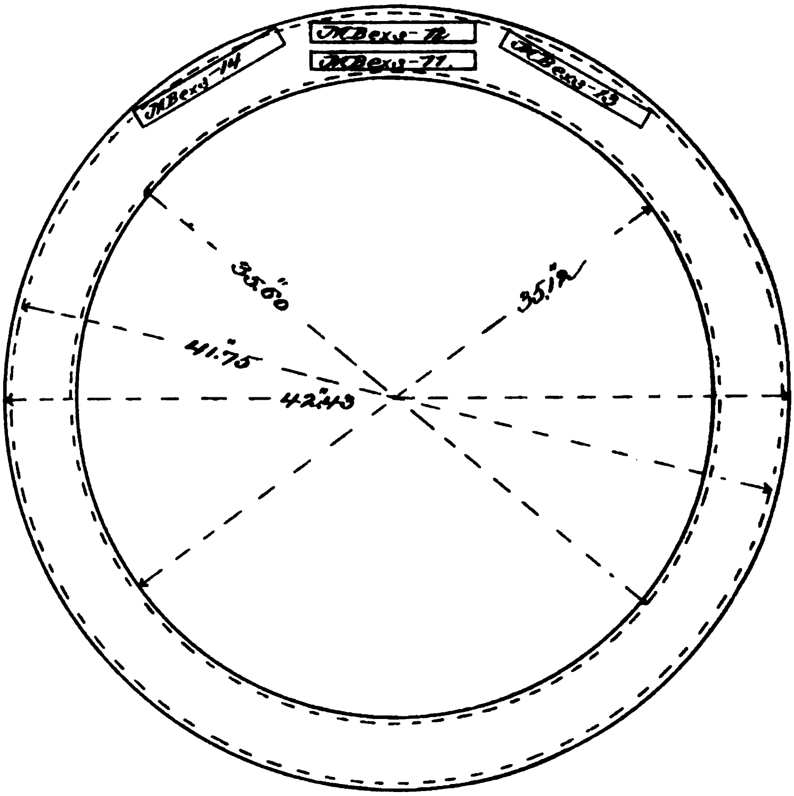
Elastic limit per square inch of original section	pounds..	50, 000
Elongation per inch under strain at elastic limit	inch..	.001810

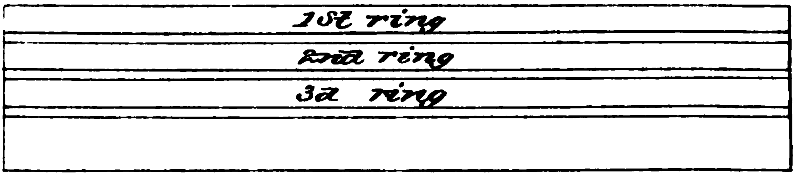
(Section C.)

Elastic limit per square inch of original section	pounds..	50, 000
Elongation per inch under strain at elastic limit	inch..	.001680

3d ring from Hoop Bex
12 inch Mortar

Rolled





Dotted circles show finished size.

No. 314.

Tension test.

Marks on bar, $^{\text{M. Ser. 3}}_{\text{11.}}$
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000133	.000133	0.	....	
2, 500	10, 000	.000300	.000167	.000017	.000017	
3, 750	15, 000	.000467	.000167	.000017	0.	
5, 000	20, 000	.000617	.000150	.000033	.000016	
6, 250	25, 000	.000767	.000150	.000050	.000017	
7, 500	30, 000	.000933	.000166	.000050	0.	
8, 750	35, 000	.001100	.000167	.000067	.000017	
10, 000	40, 000	.001267	.000167	.000067	0.	
10, 250	41, 000	.001267	0.	....	....	
10, 500	42, 000	.001300	.000033	....	....	
10, 750	43, 000	.001350	.000050	....	....	
11, 000	44, 000	.001383	.000033	....	....	
11, 250	45, 000	.001417	.000034	.000083	.000016	
11, 500	46, 000	.001450	.000033	....	....	
11, 750	47, 000	.001483	.000033	....	....	
12, 000	48, 000	.001533	.000050	....	....	
12, 250	49, 000	.001550	.000017	....	....	
12, 500	50, 000	.001600	.000050	.000100	.000017	
12, 750	51, 000	.001633	.000033	....	....	
13, 000	52, 000	.001667	.000034	....	....	
13, 250	53, 000	.001700	.000033	....	....	
13, 500	54, 000	.001733	.000033	....	....	
13, 750	55, 000	.001767	.000034	.000117	.000017	
14, 000	56, 000	.001850	.000083	....	....	
14, 250	57, 000	.001883	.000033	....	....	
14, 500	58, 000	.001950	.000067	....	....	Elastic limit.
14, 750	59, 000	.002067	.000117	....	....	
15, 000	60, 000	.002283	.000216	.000417	.000300	
15, 250	61, 000	.002917	.000634	....	....	
15, 500	62, 000	.003833	.000916	....	....	
15, 750	63, 000	.004150	.000317	....	....	
16, 000	64, 000	.005667	.001517	....	....	
16, 250	65, 000	.006267	.000600	.003900	.003483	
16, 500	66, 000	.006467	.000200	....	....	
16, 750	67, 000	.006717	.000250	....	....	
17, 000	68, 000	.007133	.000416	....	....	
17, 250	69, 000	.008217	.001084	....	....	
17, 500	70, 000	.008883	.000666	.006233	.002333	
18, 000	72, 000	.010267	.001384	....	....	
18, 500	74, 000	.012117	.001850	....	....	
19, 000	76, 000	.013767	.001650	....	....	
19, 500	78, 000	.015283	.001516	....	....	
20, 000	80, 000	.016817	.001534	....	....	
20, 500	82, 000	.018833	.002016	....	....	
21, 000	84, 000	.020950	.002117	....	....	
21, 500	86, 000	.022583	.001633	....	....	
22, 000	88, 000	.024967	.002384	....	....	
22, 500	90, 000	.027450	.002483	....	....	
23, 000	92, 000	.020967	.002517	....	....	
23, 500	94, 000	.033333	.003366	....	....	
24, 000	96, 000	.036333	.003000	....	....	
24, 500	98, 000	.039833	.003500	....	....	
25, 000	100, 000	.044567	.004734	....	....	Micrometer removed.
25, 500	102, 000	.0500	.005433	....	....	
26, 000	104, 000	.0583	.0083	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
26, 500	106, 000	.0767	.0184	....	....	
27, 000	108, 000	.0867	.0100	....	....	
27, 240	108, 960	.1117	.0250	....	....	Ultimate strength.
24, 900	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section ....pounds.. 106, 960
Elastic limit per square inch of original section..do.... 55, 000
Elongation per inch after rupture...inch.. .1317
Elongation per inch under strain at elastic limit ....do... .001950
Reduction in diameter at point of rupture.. .114
Reduction in area after rupture, per centum of original section............................. 36.4
Position of rupture...".60 from neck.
Character of broken surface ....granular 60 per cent., dull center 40 per cent.
Elongation of inch sections........................".12 ".11 ".10 ".10 ".11 (".25 fractured section).

No. 315.

Tension test.

Marks on bar, M. Bxx 3 12.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000117	.000117	0.	....	
2, 500	10, 000	.000333	.000116	0.	....	
3, 750	15, 000	.000450	.000117	0.	....	
5, 000	20, 000	.000617	.000167	.000017	.000017	
6, 250	25, 000	.000783	.000116	.000017	0.	
7, 500	30, 000	.000933	.000200	.000033	.000016	
8, 750	35, 000	.001050	.000117	.000050	.000017	
10, 000	40, 000	.001217	.000167	.000050	0.	
10, 250	41, 000	.001267	.000050	....	....	
10, 500	42, 000	.001300	.000033	....	....	
10, 750	43, 000	.001333	.000033	....	....	
11, 000	44, 000	.001367	.000034	....	....	
11, 250	45, 000	.001400	.000033	.000067	.000017	
11, 500	46, 000	.001467	.000067	....	....	
11, 750	47, 000	.001500	.000033	....	....	
12, 000	48, 000	.001533	.000033	....	....	
13, 250	49, 000	.001567	.000034	....	....	
12, 500	50, 000	.001600	.000083	.000083	.000016	
12, 750	51, 000	.001633	.000033	....	....	
13, 000	52, 000	.001667	.000034	....	....	
13, 250	53, 000	.001700	.000033	....	....	
13, 500	54, 000	.001750	.000050	....	....	Elastic limit.
13, 750	55, 000	.001817	.000067	.000150	.000067	
14, 000	56, 000	.001900	.000083	....	....	
14, 250	57, 000	.002033	.000133	....	....	
14, 500	58, 000	.002933	.000900	....	....	
14, 750	59, 000	.003567	.000634	....	....	
15, 000	60, 000	.004400	.000833	.002300	.002150	
15, 250	61, 000	.004783	.000383	....	....	
15, 500	62, 000	.005367	.000584	....	....	
15, 750	63, 000	.006033	.000666	....	....	
16, 000	64, 000	.006733	.000700	....	....	
16, 250	65, 000	.007533	.000800	.005183	.002883	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch*	*Inch.*	*Inch.*	
16, 550	66, 000	.008133	.000600	....	....	
16, 750	67, 000	.008700	.000567	....	....	
17, 000	68, 000	.008800	.000100	....	....	
17, 250	69, 000	.010200	.001400	....	....	
17, 500	70, 000	.011300	.001100	.008617	.003434	
18, 000	72, 000	.012617	.001317	....	....	
18, 500	74, 000	.013967	.001350	....	....	
19, 000	76, 000	.015867	.001900	....	....	
19, 500	78, 000	.017950	.002083	....	....	
20, 000	80, 000	.019883	.001933	....	....	
20, 500	82, 000	.021917	.002034	....	....	
21, 000	84, 000	.023950	.002033	....	....	
21, 500	86, 000	.026067	.002117	....	....	
22, 000	88, 000	.028783	.002716	....	....	
22, 500	90, 000	.031750	.002967	....	....	
23, 000	92, 000	.034800	.003050	....	....	
23, 500	94, 000	.038233	.003433	....	....	
24, 000	96, 000	.042650	.004417	....	....	
24, 500	98, 000	.048867	.006217	....	....	
25, 000	100, 000	.052500	.003633	....	....	Micrometer removed.
25, 500	102, 000	.0650	.0125	....	....	
26, 000	104, 000	.0783	.0133	....	....	
26, 500	106, 000	.1033	.0250	....	....	
26, 610	106, 440	.1233	.0200	....	....	Ultimate strength.
24, 200	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	106, 440
Elastic limit per square inch of original section	do....	54, 000
Elongation per inch after rupture	inch..	.1633
Elongation per inch under strain at elastic limit	do...	.001750
Reduction in diameter at point of rupture	do...	.114
Reduction in area after rupture, per centum of original section		36.4
Position of rupture		[illegible]" from middle of stem
Character of broken surface		dull spongy, interspersed with fine granulation
Elongation of inch sections		".12, ".15, ".19 (".32 fractured section), ".13, ".07

No. 316.

Tension test.

Marks on bar, M. BEX 3. 13.
Length, 6".00.
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000133	.000133	0.	....	
2, 500	10, 000	.000267	.000134	0.	....	
3, 750	15, 000	.000417	.000150	0.	....	
5, 000	20, 000	.000567	.000150	0.	....	
6, 250	25, 000	.000717	.000150	0.	....	
7, 500	30, 000	.000867	.000150	0.	....	
8, 750	35, 000	.001033	.000166	0.	....	
10, 000	40, 000	.001200	.000167	0.	....	
10, 250	41, 000	.001217	.000917	....	....	
10, 500	42, 000	.001250	.000083	....	....	
10, 750	43, 000	.001283	.000033	....	....	
11, 000	44, 000	.001317	.000034	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
11, 250	45, 000	.001350	.000083	.000017	.000017	
11, 500	46, 000	.001400	.000050	....	....	
11, 750	47, 000	.001433	.000033	....	....	
12, 000	48, 000	.001467	.000034	....	....	
12, 250	49, 000	.001517	.000050	....	....	
12, 500	50, 000	.001583	.000066	.000100	.000083	
12, 750	51, 000	.001650	.000067	....	....	Elastic limit.
13, 000	52, 000	.001950	.000300	....	....	
13, 250	53, 000	.003917	.001967	....	....	
13, 500	54, 000	.004633	.000716	....	....	
13, 750	55, 000	.005083	.000450	.003100	.003000	
14, 000	56, 000	.005717	.000634	....	....	
14, 250	57, 000	.006167	.000450	....	....	
14, 500	58, 000	.006917	.000750	....	....	
14, 750	59, 000	.007517	.000600	....	....	
15, 000	60, 000	.008633	.001116	.006350	.003250	
15, 250	61, 000	.009083	.000450	....	....	
15, 500	62, 000	.009717	.000634	....	....	
15, 750	63, 000	.010283	.000566	....	....	
16, 000	64, 000	.011217	.000934	....	....	
17, 250	65, 000	.011950	.000733	.009433	.003083	
16, 500	66, 000	.012583	.000633	....	....	
16, 750	67, 000	.013267	.000684	....	....	
17, 000	68, 000	.014083	.000816	....	....	
17, 250	69, 000	.014900	.000817	....	....	
17, 500	70, 000	.016367	.001467	.013467	.004034	
18, 000	72, 000	.017867	.001500	....	....	
18, 500	74, 000	.019850	.001983	....	....	
19, 000	76, 000	.021900	.002050	....	....	
19, 500	78, 000	.023983	.002083	....	....	
20, 000	80, 000	.026350	.002367	....	....	
20, 500	82, 000	.029000	.002650	....	....	
21, 000	84, 000	.031333	.002333	....	....	
21, 500	86, 000	.034617	.003284	....	....	
22, 000	88, 000	.039033	.004416	....	....	
22, 500	90, 000	.042117	.003084	....	....	
23, 000	92, 000	.047683	.005566	....	....	
23, 500	94, 000	.052967	.005284	....	....	Micrometer removed.
24, 000	96, 000	.0617	.008733	....	....	
24, 500	98, 000	.0717	.0100	....	....	
25, 000	100, 000	.0883	.0166	....	....	
25, 500	102, 000	.1233	.0350	....	....	Ultimate strength.
23, 000	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds	102, 000
Elastic limit per square inch of original section	do	51, 000
Elongation per inch after rupture	inch	0. 17
Elongation per inch under strain at elastic limit	do	.001650
Reduction in diameter at point of rupture		.1234
Reduction in area after rupture, per centum of original section		39. 2
Position of rupture		at middle of stem
Character of broken surface		dull spongy, interspersed with fine granulation
Elongation of inch sections		".10 ".15 (".30 fractured section) ".22 ".14 "11

No. 376.

Compression test.

Marks on bar, M. $\frac{\text{Bxx 3}}{\text{14.}}$
Length, 8″.96.
Diameter, 1″.129.
Sectional area, 1 square inch.

Compression measurement not taken, the length of specimen not admitting the application of the micrometer.

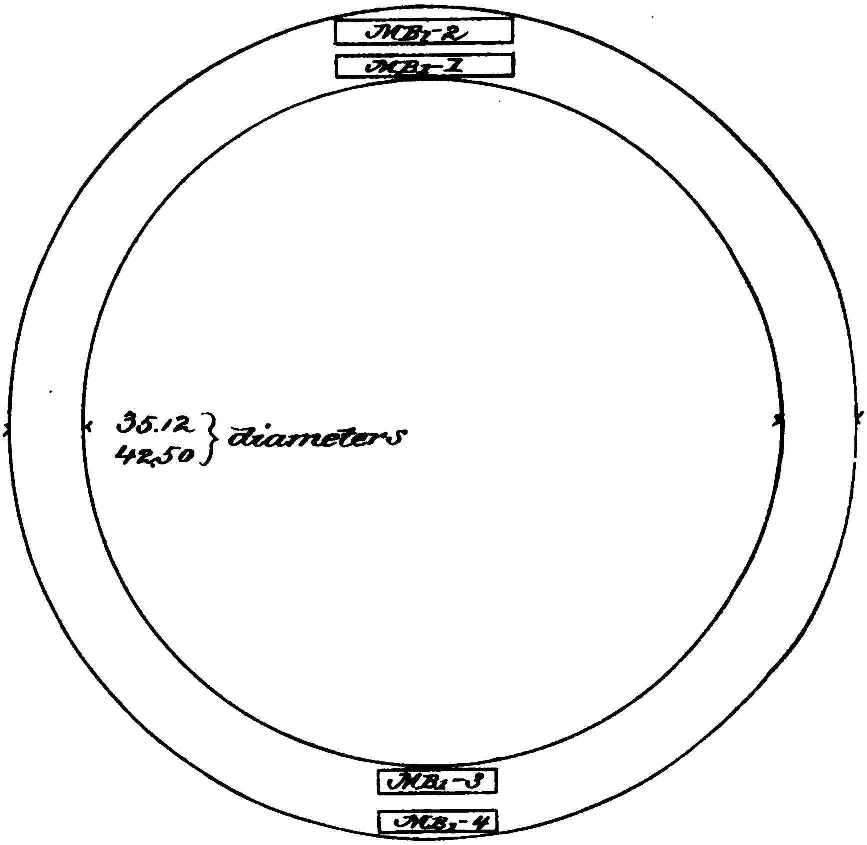
Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
62, 000	62, 000	....	....	....	....	Perceptible deflection.
79, 000	79, 000	....	....	....	....	Middle deflection, ″.15.
81, 250	81, 250	....	....	....	....	Middle deflection, ″.25; ultimate strength.

Failed by triple flexure.

Hoop B1

12 inch Mortar

Rolled



No. 304.

Tension test.

Marks on bar, $^{M.}{}_{1.}{}^{B1}$
Length, 6″.
Diameter, ″.561.
Sectional area, .247 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
247	1,000	0.	0.	0.	0.	Initial load.
1,235	5,000	.000083	.000083	0.	....	
2,470	10,000	.000217	.000134	0.	....	
3,705	15,000	.000383	.000166	0.	....	
4,940	20,000	.000517	.000134	0.	....	
6,175	25,000	.000667	.000150	0.	....	
7,410	30,000	.000833	.000166	0.	....	
8,645	35,000	.000967	.000134	0.	....	
9,880	40,000	.001117	.000150	0.	....	
10,127	41,000	.001150	.000033	....	....	
10,374	42,000	.001167	.000017	....	....	
10,621	43,000	.001183	.000016	....	....	
10,868	44,000	.001200	.000017	....	....	
11,115	45,000	.001233	.000033	0.	....	
11,362	46,000	.001267	.000034	....	....	
11,609	47,000	.001300	.000033	....	....	
11,856	48,000	.001333	.000033	....	....	
12,103	49,000	.001383	.000050	....	....	
12,350	50,000	.001417	.000034	0.	....	
12,597	51,000	.001433	.000016	....	....	
12,844	52,000	.001467	.000034	....	....	
13,091	53,000	.001483	.000016	....	....	
13,338	54,000	.001567	.000084	....	....	
13,585	55,000	.001583	.000016	0.	....	
13,832	56,000	.001600	.000017	....	....	
14,079	57,000	.001617	.000017	....	....	
14,326	58,000	.001650	.000033	....	....	
14,573	59,000	.001683	.000033	....	....	
14,820	60,000	.001717	.000034	.000017	.000017	
15,067	61,000	.001767	.000050	....	....	
15,314	62,000	.001800	.000033	....	....	
15,561	63,000	.001833	.000033	....	....	
15,808	64,000	.001883	.000050	....	....	
16,055	65,000	.001917	.000034	.000017	0.	
16,302	66,000	.001933	.000016	....	....	
16,549	67,000	.001983	.000050	....	....	
16,796	68,000	.002000	.000017	....	....	
17,043	69,000	.002067	.000067	....	....	
17,290	70,000	.002083	.000016	.000017	0.	
17,537	71,000	.002117	.000034	....	....	
17,784	72,000	.002167	.000050	....	....	Elastic limit.
18,031	73,000	.002233	.000066	....	....	
18,278	74,000	.002833	.000600	....	....	
18,525	75,000	.004250	.001417	.001800	.001783	
18,772	76,000	.005050	.000800	....	....	
19,019	77,000	.005900	.000850	....	....	
19,266	78,000	.006783	.000883	....	....	
19,513	79,000	.007833	.001050	....	....	
19,760	80,000	.008717	.000884	.005883	.004083	
20,254	82,000	.010150	.001433	....	....	
20,748	84,000	.011933	.001783	....	....	
21,242	86,000	.013483	.001550	....	....	
21,736	88,000	.015783	.002300	....	....	
22,230	90,000	.017550	.001767	....	....	
22,724	92,000	.019317	.001767	....	....	
23,218	94,000	.021833	.002516	....	....	Micrometer removed.
23,712	96,000	.0233	.001467	....	....	
24,206	98,000	.0250	.0017	....	....	
24,700	100,000	.0283	.0033	....	....	
25,194	102,000	.0317	.0034	....	....	
25,688	104,000	.0350	.0033	....	....	
26,182	106,000	.0375	.0025	....	....	
26,676	108,000	.0433	.0058	....	....	
27,170	110,000	.0483	.0050	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
27,664	112,000	.0550	.0067	....	....	
28,158	114,000	.0650	.0100	....	....	
28,652	116,000	.0800	.0150	....	....	
28,790	116,560	.0917	.0117	....	....	
29,000	117,410	.1117	.0200	....	....	Ultimate strength.
24,700	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	117,410
Elastic limit per square inch of original section	do....	72,000
Elongation per inch after rupture	inch..	0.145
Elongation per inch under strain at elastic limit	do ...	.002167
Reduction in diameter at point of rupture	do....	.141
Reduction in area after rupture, per centum of original section		43.7
Position of rupture		1½″ from neck
Character of broken surface		silky, interspersed with fine granulation
Elongation of inch sections		″.10, ″.11, ″.12, ″.10 (″.30 fractured section), ″.14

No. 305.

Tension test.

Marks on bar, $^{\text{M. B.}}_{2}$.1
Length, 6″.
Diameter, ″.561.
Sectional area, .247 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
247	1,000	0.	0.	0.	0.	Initial load.
1,235	5,000	.000133	.000133	0.	....	
2,470	10,000	.000283	.000150	0.	....	
3,705	15,000	.000417	.000134	0.	....	
4,940	20,000	.000550	.000133	0.	....	
6,175	25,000	.000700	.000150	0.	....	
7,410	30,000	.000867	.000167	0.	....	
8,645	35,000	.001017	.000150	0.	....	
9,880	40,000	.001183	.000166	0.	....	
10,127	41,000	.001200	.000017	....	....	
10,374	42,000	.001217	.000017	....	....	
10,621	43,000	.001250	.000033	....	....	
10,868	44,000	.001283	.000033	....	....	
11,115	45,000	.001317	.000034	.000033	.000033	
11,362	46,000	.001350	.000033	....	....	
11,609	47,000	.001383	.000033	....	....	
11,856	48,000	.001417	.000034	....	....	
12,103	49,000	.001450	.000033	....	....	
12,350	50,000	.001483	.000033	.000033	0.	
12,597	51,000	.001517	.000034	....	....	
12,844	52,000	.001550	.000033	....	....	
13,091	53,000	.001583	.000033	....	....	
13,338	54,000	.001617	.000034	....	....	
13,585	55,000	.001650	.000033	.000050	.000017	
13,832	56,000	.001683	.000033	....	....	
14,079	57,000	.001700	.000017	....	....	
14,326	58,000	.001733	.000033	....	....	
14,573	59,000	.001767	.000034	....	....	
14,820	60,000	.001800	.000033	.000067	.000017	
15,067	61,000	.001867	.000067	....	....	
15,314	62,000	.001900	.000033	....	....	
15,561	63,000	.001933	.000033	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
15,805	64,000	.001967	.000034	....	....	
16,055	65,000	.002000	.000033	.000083	.000016	
16,302	66,000	.002017	.000017	....	....	
16,549	67,000	.002050	.000033	....	....	
16,796	68,000	.002083	.000033	....	....	
17,043	69,000	.002117	.000034	....	....	
17,290	70,000	.002167	.000050	.000100	.000017	
17,537	71,000	.002200	.000033	....	....	
17,784	72,000	.002250	.000050	....	....	**Elastic limit.**
18,031	73,000	.002350	.000100	....	....	
18,278	74,000	.002933	.000583	....	....	
18,525	75,000	.004300	.001367	.001833	.001733	
18,772	76,000	.005283	.000983	....	....	
19,019	77,000	.006050	.000767	....	....	
19,266	78,000	.006983	.000933	....	....	
19,513	79,000	.007750	.000767	....	....	
19,760	80,000	.008750	.001000	.005883	.004050	
20,254	82,000	.010233	.001483	....	....	
20,748	84,000	.011567	.001334	....	....	
21,242	86,000	.013667	.002100	....	....	
21,736	88,000	.015500	.001833	....	....	
22,230	90,000	.017450	.001950	....	....	
22,724	92,000	.019300	.001850	....	....	
23,218	94,000	.021450	.002150	....	....	**Micrometer removed.**
23,712	96,000	.0233	.001850	....	....	
24,206	98,000	.0250	.0017	....	....	
24,700	100,000	.0267	.0017	....	....	
25,194	102,000	.0300	.0033	....	....	
25,688	104,000	.0333	.0033	....	....	
26,182	106,000	.0383	.0050	....	....	
26,676	108,000	.0433	.0050	....	....	
27,170	110,000	.0483	.0050	....	....	
27,664	112,000	.0517	.0034	....	....	
28,158	114,000	.0583	.0066	....	....	
28,652	116,000	.0717	.0134	....	....	
29,100	117,810	.1083	.0366	....	....	Ultimate strength.
24,800	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	117,810
Elastic limit per square inch of original section	do...	72,000
Elongation per inch after rupture	inch..	0.1333
Elongation per inch under strain at elastic limit	do...	.002250
Reduction in diameter at point of rupture		.141
Reduction in area after rupture, per centum of original section		43.7
Position of rupture		1″.10 from neck.
Character of broken surface		silky, interspersed with fine granulation.
Elongation of inch sections		″.08, ″.06, ″.10, ″.10, ″.17 (″.27 fractured section).

No. 306.

Tension test.

Marks on bar, $^{M}_{3}{}^{B}1$.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000100	.000100	0.	....	
2, 500	10, 000	.000200	.000100	0.	....	
3, 750	15, 000	.000333	.000133	0.	....	
5, 000	20, 000	.000533	.000200	0.	....	
6, 250	25, 000	.000667	.000134	0.	....	
7, 500	30, 000	.000867	.000200	0.	....	
8, 750	35, 000	.001000	.000133	0.	....	
10, 000	40, 000	.001167	.000167	.000033	.000033	
10, 250	41, 000	.001167	0.	....	....	
10, 500	42, 000	.001200	.000033	....	....	
10, 750	43, 000	.001233	.000033	....	....	
11, 000	44, 000	.001267	.000034	....	....	
11, 250	45, 000	.001300	.000033	.000033	0.	
11, 500	46, 000	.001333	.000033	....	....	
11, 750	47, 000	.001367	.000034	....	....	
12, 000	48, 000	.001400	.000033	....	....	
12, 250	49, 000	.001433	.000033	....	....	
12, 500	50, 000	.001433	0.	.000067	.000034	
12, 750	51, 000	.001467	.000034	....	....	
13, 000	52, 000	.001500	.000033	....	....	
13, 250	53, 000	.001533	.000033	....	....	
13, 500	54, 000	.001600	.000067	....	....	
13, 750	55, 000	.001667	.000067	.000067	0.	
14, 000	56, 000	.001667	0.	....	....	
14, 250	57, 000	.001700	.000033	....	....	
14, 500	58, 000	.001733	.000033	....	....	
14, 750	59, 000	.001767	.000034	....	....	
15, 000	60. 000	.001800	.000033	.000100	.000033	
15, 250	61, 000	.001867	.000067	....	....	
15, 500	62, 000	.001900	.000033	....	....	
15, 750	63, 000	.001933	.000033	....	....	
16, 000	64, 000	.001967	.000034	....	....	
16, 250	65, 000	.002000	.000033	.000100	0.	
16, 500	66, 000	.002100	.000100	....	....	
16, 750	67, 000	.002133	.000033	....	....	
17. 000	68, 000	.002133	0.	....	....	
17, 250	69, 000	.002167	.000034	....	....	
17, 500	70, 000	.002200	.000033	.000133	.000033	
17, 750	71, 000	.002200	0.	....	....	
18, 000	72, 000	.002267	.000067	....	....	
18, 250	73, 000	.002333	.000066	....	....	Elastic limit.
18, 500	74, 000	.002767	.000434	....	....	
18, 750	75, 000	.004000	.001233	.001700	.001567	
19, 000	76, 400	.004867	.000867	....	....	
19, 250	77, 000	.005833	.000966	....	....	
19, 500	78, 000	.006833	.001000	....	....	
19, 750	79, 000	.007500	.000667	....	....	
20. 000	80, 000	.008700	.001200	.005833	.004133	
20, 500	82, 000	.010200	.001500	....	....	
21, 000	84, 000	.011767	.001567	....	....	
21, 500	86, 000	.014033	.002266	....	....	
22, 000	88, 000	.015367	.001334	....	....	
22, 500	90, 000	.017800	.002433	....	....	
23, 000	92, 000	.019367	.001567	....	....	
23, 500	94, 000	.020067	.000700	....	....	
24, 000	96, 000	.024000	.003933	....	....	
24, 500	98, 000	.025800	.001800	....	....	
25, 000	100, 000	.029600	.003800	....	....	Micrometer removed.
25, 500	102, 000	.0317	.0021	....	....	
26, 000	104, 000	.0333	.0016	....	....	
26, 500	106, 000	.0367	.0034	....	....	
27, 000	108, 000	.0433	.0066	....	....	
27, 500	110, 000	.0467	.0034	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28, 000	112, 000	. 0533	. 0066	....	....	
28, 500	114, 000	. 0633	. 0100	....	....	
29, 000	116, 000	. 0800	. 0167	....	....	
29, 360	117, 440	. 1133	. 0333	....	....	Ultimate strength.
24, 300	....	....	....	....	....	Load at time of rupture.

General summary.

Specific gravity	7. 8523
Hardness	26. 51
Tensile strength per square inch of original section ......pounds..	117, 400
Elastic limit per square inch of original section ......do...	78, 000
Elongation per inch after rupture ......inch..	0. 17
Elongation per inch under strain at elastic limit ......do...	. 002333
Reduction in diameter at point of rupture ......do...	. 154
Reduction in area after rupture, per centum of original section	47. 2
Position of rupture	1″ from neck.
Character of broken surface	silky, interspersed with fine granulation.
Elongation of inch sections	″.09, ″.14 (″.28 fractured section).

No. 307.

Tension test.

Marks on bar, $^{\mathrm{M.\ B.}}_{\mathrm{41.}}$
Length, 3″.
Diameter, ″.561.
Sectional area, .247 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
247	1, 000	0.	0.	0.	0.	Initial load.
1, 235	5, 000	. 000000	. 000000	—. 000033	—. 000033	
2, 470	10, 000	. 000167	. 000167	—. 000033	0.	
3, 705	15, 000	. 000300	. 000133	—. 000033	0.	
4, 940	20, 000	. 000400	. 000100	—. 000033	0.	
6, 175	25, 000	. 000600	. 000200	—. 000033	0.	
7, 410	30, 000	. 000700	. 000100	—. 000033	0.	
8, 645	35, 000	. 000900	. 000200	—. 000033	0.	
9, 880	40, 000	. 000967	. 000067	—. 000033	0.	
10, 127	41, 000	. 001067	. 000100	....	....	
10, 874	42, 000	. 001133	. 000066	....	....	
10, 621	43, 000	. 001167	. 000034	....	....	
10, 868	44, 000	. 001200	. 000033	....	....	
11, 115	45, 000	. 001233	. 000033	—. 000033	0.	
11, 362	46, 000	. 001233	0.	....	....	
11, 609	47, 000	. 001267	. 000034	....	....	
11, 856	48, 000	. 001300	. 000033	....	....	
12, 103	49, 000	. 001300	0.	....	....	
12, 350	50, 000	. 001333	. 000033	—. 000033	0.	
12, 597	51, 000	. 001333	0.	....	....	
12, 844	52, 000	. 001400	. 000077	....	....	
13, 091	53, 000	. 001433	. 000033	....	....	
13, 338	54, 000	. 001433	0.	....	....	
13, 585	55, 000	. 001467	. 000034	—. 000033	0.	
13, 832	56, 000	. 001500	. 000033	....	....	
14, 079	57, 000	. 001533	. 000033	....	....	
14, 326	58, 000	. 001567	. 000034	....	....	
14, 573	59, 000	. 001600	. 000033	....	....	
14, 820	60, 000	. 001633	. 000033	0.	. 000033	
15, 067	61, 000	. 001667	. 000034	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
15, 314	62, 000	.001700	.000033			
15, 561	63, 000	.001733	.000033			
15, 808	64, 000	.001767	.000034			
16, 055	65, 000	.001800	.000033	0.	0.	
16, 302	66, 000	.001867	.000067			
16, 549	67, 000	.001900	.000033			
16, 796	68, 000	.001933	.000033			
17, 043	69, 000	.001967	.000034	.000033	.000033	
17, 290	70, 000	.002000	.000033			
17, 537	71, 000	.002033	.000033			
17, 784	72, 000	.002067	.000034			
18, 031	73, 000	.002100	.000033			Elastic limit.
18, 278	74, 000	.002300	.000200			
18, 525	75, 000	.004300	.002000	.001967	.001934	
18, 772	76, 000	.004800	.000500			
19, 019	77, 000	.005500	.000700			
19, 266	78, 000	.006567	.001067			
19, 518	79, 000	.007500	.000933			
19, 760	80, 000	.008267	.000767	.005433	.003466	
20, 254	82, 000	.009867	.001600			
20, 748	84, 000	.011667	.001800			
21, 242	86, 000	.013767	.002100			
21, 736	88, 000	.015233	.001466			
22, 230	90, 000	.017333	.002100			
22, 724	92, 000	.019467	.002134			
23, 218	94, 000	.021500	.002033			
23, 712	96, 000	.023467	.001967			
24, 206	98, 000	.025500	.002033			
24, 700	100, 000	.028233	.002733			Micrometer removed.
25, 190	102, 000	.0333	.005067			
25, 688	104, 000	.0367	.0034			
26, 182	106, 000	.0400	.0033			
26, 676	108, 000	.0433	.0033			
27, 170	110, 000	.0483	.0050			
27, 664	112, 000	.0533	.0050			
28, 158	114, 000	.0667	.0134			
28, 652	116, 000	.0767	.0100			
29, 146	118, 000	.1133	.0366			Ultimate strength.
24, 100						Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds	118, 000
Elastic limit per square inch of original section	do	73, 000
Elongation per inch after rupture	inch	0. 1733
Elongation per inch under strain at elastic limit	do	.002100
Reduction in diameter at point of rupture	do	.141
Reduction in area after rupture, per centum of original section		43.7
Position of rupture		".95 from neck.
Character of broken surface		silky, interspersed with fine granulation.
Elongation of inch sections		".09 ".13 (".30 fractured section).

STEEL FROM TUBE FOR 8" B. L. RIFLE.

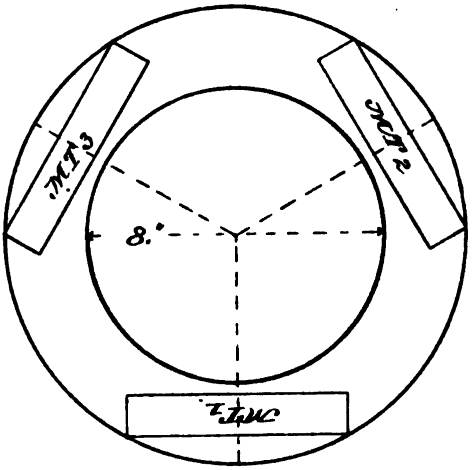
[From Midvale Steel Works.]

Explanation of marks on specimens from 8" tube.

B. T.—Breech tangential.
B. L.—Breech longitudinal.
M. T.—Muzzle tangential.
B. R.—Breech radial.
M. R.—Muzzle radial.

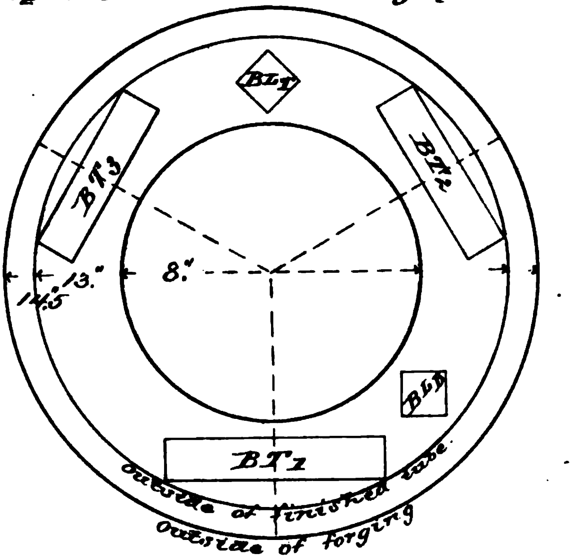
8 inch Tube.

Muzzle end



Breech end

Top of tube in annealing pit.



No. 123.

Tension test.

Marks on bar, M. T. 1.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000200	.000200	.000000	.000000	
2,500	10,000	.000433	.000233	.000033	.000033	
3,750	15,000	.000567	.000134	.000067	.000034	
5,000	20,000	.000733	.000166	.000100	.000033	
6,250	25,000	.000900	.000167	.000133	.000033	
6,500	26,000	.000933	.000033	....	....	
6,750	27,000	.000967	.000034	....	....	
7,000	28,000	.001070	.000103	....	....	
7,250	29,000	.001100	.000030	....	....	
7,500	30,000	.001133	.000033	.000133	0.	
7,750	31,000	.001133	0.	....	....	
8,000	32,000	.001200	.000067	....	....	
8,250	33,000	.001233	.000033	....	....	
8,500	34,000	.001267	.000034	....	....	
8,750	35,000	.001267	0.	.000133	0.	
9,000	36,000	.001332	.000066	....	....	
9,250	37,000	.001400	.000067	....	....	
9,500	38,000	.001433	.000033	....	....	
9,750	39,000	.001500	.000067	....	....	
10,000	40,000	.001533	.000033	.000233	.000100	
10,250	41,000	.001567	.000034	....	....	Elastic limit.
10,500	42,000	.002100	.000533	....	....	
10,750	43,000	.004967	.002867	....	....	
11,000	44,000	.008900	.003933	....	....	
11,250	45,000	.009633	.001733	.008000	.007767	
11,500	46,000	.010400	.000767	....	....	
11,750	47,000	.011030	.000630	....	....	
12,000	48,000	.012267	.001237	....	....	
12,250	49,000	.013100	.000833	....	....	
12,500	50,000	.014400	.001300	.012434	.004433	
12,750	51,000	.014900	.000500	....	....	
13,000	52,000	.016067	.001167	....	....	
13,250	53,000	.017067	.001000	....	....	
13,500	54,000	.018767	.001700	....	....	
13,750	55,000	.019800	.001033	.017600	.005177	
14,000	56,000	.020867	.001067	....	....	
14,250	57,000	.022167	.001300	....	....	
14,500	58,000	.023833	.001666	....	....	
14,750	59,000	.024667	.000834	....	....	
15,000	60,000	.026733	.002066	.024267	.006667	
15,500	62,000	.030200	.003467	....	....	
16,000	64,000	.034233	.004033	....	....	
16,500	66,000	.038433	.004200	....	....	
17,000	68,000	.042867	.004434	....	....	
17,500	70,000	.049067	.006200	.045933	.021666	Micrometer removed.
18,000	72,000	.0533	.004233	....	....	
18,500	74,000	.0633	.0100	....	....	
19,000	76,000	.0733	.0100	....	....	
19,500	78,000	.0900	.0167	....	....	
20,000	80,000	.1100	.0200	....	....	
20,500	82,000	.1733	.0633	....	....	
20,600	82,400	.2200	.0467	....	....	Ultimate strength.
18,600	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity	7.8548
Hardness	10.98
Tensile strength per square inch of original section .... pounds	82.400
Elastic limit per square inch of original section .... do	41.000
Elongation per inch after rupture .... inch	0.28
Elongation per inch under strain at elastic limit .... do	.001567
Reduction in diameter at point of rupture	.184
Reduction in area after rupture, per centum of original section	42.0
Position of rupture	″.65 from neck
Character of broken surface	dull spongy, slightly granular.

No. 124.

Tension test.

Marks on bar, M. T. $_2$.
Length, 3''.00.
Diameter, .564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	.000100	.000100	0.	....	
2, 500	10, 000	.000333	.000232	0.	....	
3, 750	15, 000	.000433	.000100	0.	....	
5, 000	20, 000	.000633	.000200	0.	....	
6, 250	25, 000	.000733	.000100	.000033	.000033	
6, 500	26, 000	.000733	0.	....	....	
6, 750	27, 000	.000800	.000067	....	....	
7, 000	28. 000	.000867	.000067	....	....	
7, 250	29, 000	.000900	.000033	....	....	
7, 500	30, 000	.000933	.000033	.000033	0.	
7, 750	31, 000	.000933	0.	....	....	
8, 000	32, 000	.001000	.000067	....	....	
8, 250	33, 000	.001033	.000033	....	....	
8, 500	34, 000	.001033	.0	....	....	
8, 750	35, 000	.001067	.000034	.000033	0.	
9, 000	36, 000	.001067	.0	....	....	
9, 250	37, 000	.001100	.000033	....	....	
9, 500	38, 000	.001133	.000033	....	....	
9, 750	39, 000	.001200	.000067	....	....	
10, 000	40, 000	.001233	.000033	.000033	0.	
10, 250	41, 000	.001333	.000100	....	....	
10, 500	42, 000	.001367	.000034	....	....	Elastic limit.
10, 750	43, 000	.001800	.000433	....	....	
11, 000	44, 000	.009533	.007733	....	....	
11, 250	45, 000	.010267	.000734	.008633	.008600	
11, 500	46, 000	.010733	.000466	....	....	
11, 750	47, 000	.011533	.000800	....	....	
12, 000	48, 000	.012700	.001167	....	....	
12, 250	49, 000	.013700	.001000	....	....	
12, 500	50, 000	.015033	.001333	.013267	.004634	
12, 750	51, 000	.015667	.000634	....	....	
13, 000	52, 000	.016767	.001100	....	....	
13, 250	53, 000	.018367	.001600	....	....	
13, 500	54, 000	.019700	.001333	....	....	
13, 750	55, 000	.021067	.001367	.019032	.005766	
14, 000	56, 000	.021867	.000800	....	....	
14, 250	57, 000	.023267	.001400	....	....	
14, 500	58, 000	.025600	.002333	....	....	
14, 750	59, 000	.026867	.001267	....	....	
15, 000	60, 000	.029300	.002433	.026900	.007867	
15, 500	62, 000	.032167	.002867	....	....	
16, 000	64, 000	.036360	.004133	....	....	
16, 500	66, 000	.041533	.005233	....	....	
17, 000	68, 000	.045700	.004167	....	....	
17, 500	70, 000	.052400	.006700	.049567	.022667	Micrometer removed.
18, 000	72, 000	.0600	.007600	....	....	
18, 500	74, 000	.0700	.0100	....	....	
19, 000	76, 000	.0833	.0133	....	....	
19, 500	78, 000	.1033	.0200	....	....	
20, 000	80, 000	.1400	.0367	....	....	
20, 250	81, 000	.1700	.0300	....	....	Ultimate strength.
19, 300	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds	81.000
Elastic limit per square inch of original section	do	42.000
Elongation per inch after rupture	inch	0.237
Elongation per inch under strain at elastic limit	do	.001367
Reduction in diameter at point of rupture	do	.094
Reduction in area after rupture, per centum of original section		30.8
Position of rupture		1'' from neck
Character of broken surface		granular, radiating from dull spot at circumference

No 125.

Tension test.

Marks on bar, M. T.$_3$.
Length, 3″.00.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks .
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	.000062	.000067	0.	....	
2, 500	10, 000	.000133	.000066	—.000033	—.000033	
3, 750	15, 000	.000367	.000234	—.000033	0.	
5, 000	20, 000	.000467	.000100	—.000033	0.	
6, 250	25, 000	.000700	.000233	—.000033	0.	
6, 500	26, 000	.000700	0.	....	....	
6, 750	27, 000	.000733	.000033	....	....	
7, 000	28, 000	.000733	0.	....	....	
7, 250	29, 000	.000767	.000034	....	....	
7, 500	30, 000	.000767	0.	0.	.000033	
7, 750	31, 000	.000767	0.	....	....	
8, 000	32, 000	.000833	.000066	....	....	
8, 250	33, 000	.000900	.000067	....	....	
8, 500	34, 000	.000967	.000067	....	....	
8, 750	35, 000	.001033	.000066	—.000033	—.000033	
9, 000	36, 000	.001067	.000034	....	....	
9, 250	37, 000	.001100	.000033	....	....	
9, 500	38, 000	.001133	.000033	....	....	
9, 750	39, 000	.001167	.000034	....	....	
10, 000	40, 000	.001167	0.	—.000033	0.	Elastic limit.
10, 250	41, 000	.009333	.008166	....	....	
10, 500	42, 000	.009967	.000634	....	....	
10, 750	43, 000	.010500	.000533	....	....	
11, 000	44, 000	.011467	.000967	....	....	
11, 250	45, 000	.012667	.001200	.011067	.011100	
11, 500	46, 000	.013100	.000433	....	....	
11, 750	47, 000	.014267	.001167	....	....	
12, 000	48, 000	.015267	.001000	....	....	
12, 250	49, 000	.016667	.001400	....	....	
12, 500	50, 000	.018000	.001333	.016100	.005033	
12, 750	51, 000	.018667	.000667	....	....	
13, 000	52, 000	.019733	.001066	....	....	
13, 250	53, 000	.021100	.001367	....	....	
13, 500	54, 000	.022767	.001667	....	....	
13, 750	55, 000	.024000	.001233	.021800	.005700	
14, 000	56, 000	.025333	.001333	....	....	
14, 250	57, 000	.027367	.002034	....	....	
14, 500	58, 000	.029267	.001900	....	....	
14, 750	59, 000	.030700	.001433	....	....	
15, 000	60, 000	.033067	.002367	.030600	.008800	
15, 500	62, 000	.037133	.004066	....	....	
16, 000	64, 000	.042167	.005034	....	....	
16, 500	66, 000	.047133	.004966	....	....	
17, 000	68, 000	.053100	.005967	....	....	
17, 500	70, 000	.060400	.007300	.057267	.026667	Micrometer removed,
18, 000	72, 000	.0733	.0129	....	....	
18, 500	74, 000	.0867	.0134	....	....	
19, 000	76, 000	.1067	.0200	....	....	
19, 500	78, 000	.1300	.0233	....	....	
19, 780	79, 120	.1767	.0467	....	....	Ultimate strength.
17, 400	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	79, 120
Elastic limit per square inch of original section	do....	49, 000
Elongation per inch after rupture	inch ..	0. 26
Elongation per inch under strain at elastic limit	do....	.001167
Reduction in diameter at point of rupture	do....	.134
Reduction in area after rupture, per centum of original section		42. 0
Position of rupture		″.8 from neck.
Character of broken surface		dull spongy, slightly granular.

No. 114.

Tension test.

Marks on bar, B. T. 1.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000200	.000200	0.	....	
2,500	10,000	.000333	.000133	0.	....	
3,750	15,000	.000500	.000167	0.	....	
5,000	20,000	.000633	.000133	0.	....	
6,250	25,000	.000800	.000167	0.	....	
7,500	30,000	.000967	.000167	.000033	.000033	
8,750	35,000	.001100	.000133	.000067	.000034	
9,000	36,000	.001233	.000133	....	....	
9,250	37,000	.001300	.000067	....	....	
9,500	38,000	.001400	.000100	....	....	Elastic limit.
9,750	39,000	.002700	.001300	....	....	
10,000	40,000	.004733	.002033	.003533	.003466	
10,250	41,000	.006033	.001300	....	....	
10,500	42,000	.006800	.000767	....	....	
10,750	43,000	.007633	.000833	....	....	
11,000	44,000	.008533	.000900	....	....	
11,250	45,000	.009400	.000867	.007833	.004300	
11,500	46,000	.010267	.000867	....	....	
11,750	47,000	.011233	.000966	....	....	
12,000	48,000	.012367	.001134	....	....	
12,250	49,000	.013300	.000933	....	....	
12,500	50,000	.014600	.001300	.012667	.004834	
12,750	51,000	.015367	.000767	....	....	
13,000	52,000	.016333	.000966	....	....	
13,250	53,000	.017533	.001200	....	....	
13,500	54,000	.019567	.002034	....	....	
13,750	55,000	.020733	.001166	.018300	.005633	
14,000	56,000	.021667	.000934	....	....	
14,250	57,000	.023033	.001366	....	....	
14,500	58,000	.025033	.002000	....	....	
14,750	59,000	.026400	.001367	....	....	
15,000	60,000	.028333	.001933	.026000	.007700	
15,500	62,000	.032267	.003934	....	....	
16,000	64,000	.036067	.003800	....	....	
16,500	66,000	.041867	.005800	....	....	
17,000	68,000	.046733	.004866	....	....	
17,500	70,000	.053167	.006434	.050100	.024100	Micrometer removed.
18,000	72,000	.0600	.006833	....	....	
18,500	74,000	.0733	.0133	....	....	
19,000	76,000	.0900	.0167	....	....	
19,500	78,000	.1200	.0300	....	....	
19,770	79,080	.1567	.0367	....	....	Ultimate strength.
17,900	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity	7.8565
Hardness	12.84
Tensile strength per square inch of original section .... pounds..	79,080
Elastic limit per square inch of original section .... do....	38,000
Elongation per inch after rupture .... inch..	0.20
Elongation per inch under strain at elastic limit .... do....	.001400
Reduction in diameter at point of rupture .... do....	.084
Reduction in area after rupture, per centum of original section	27.6
Position of rupture	″.6 from neck.
Character of broken surface	granular 80 per cent., radiating from a dull spot at circumference; surface cracks developed on the stem.

No. 121.

Tension test.

Marks on bar, B T 2.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	.000233	.000233	0.	....	
2, 500	10, 000	.000400	.000167	.000033	.000033	
3, 750	15, 000	.000533	.000133	.000067	.000034	
5, 000	20, 000	.000667	.000134	.000100	.000033	
6, 250	25, 000	.000867	.000200	....	....	
6, 500	26, 000	.000867	0.	....	....	
6, 750	27, 000	.000900	.000033	....	....	
7, 000	28, 000	.000933	.000033	....	....	
7, 250	29, 000	.000967	.000034	....	....	
7, 500	30, 000	.001000	.000033	.000133	.000033	
7, 750	31, 000	.001100	.000100	....	....	
8, 000	32, 000	.001133	.000033	....	....	
8, 250	33, 000	.001167	.000034	....	....	
8, 500	34, 000	.001200	.000033	....	....	
8, 750	35, 000	.001233	.000033	.000233	.000100	Elastic limit.
9, 000	36, 000	.001367	.000134	....	....	
9, 250	37, 000	.001467	.000100	....	....	
9, 500	38, 000	.001700	.000233	....	....	
9, 750	39, 000	.002133	.000433	....	....	
10, 000	40, 000	.004233	.002100	.002933	.002700	
10, 250	41, 000	.005367	.001134	....	....	
10, 500	42, 000	.006367	.001000	....	....	
10, 750	43, 000	.007033	.000666	....	....	
11, 000	44, 000	.007933	.000900	....	....	
11, 250	45, 000	.008900	.000967	.007300	.004367	
11, 500	46, 000	.009567	.000667	....	....	
11, 750	47, 000	.010500	.000933	....	....	
12, 000	48, 000	.011633	.001133	....	....	
12, 250	49, 000	.012500	.000867	....	....	
12, 500	50, 000	.013733	.001233	.012300	.005000	
12, 750	51, 000	.014233	.000500	....	....	
13, 000	52, 000	.015533	.001300	....	....	
13, 250	53, 000	.016900	.001367	....	....	
13, 500	54, 000	.017933	.001133	....	....	
13, 750	55, 000	.019267	.001334	.017233	.004933	
14, 000	56, 000	.020333	.001066	....	....	
14, 250	57, 000	.022233	.001900	....	....	
14, 500	58, 000	.024067	.001834	....	....	
14, 750	59, 000	.025400	.001333	....	....	
15, 000	60, 000	.027233	.001833	.024933	.007700	
15, 500	62, 000	.030300	.003067	....	....	
16, 000	64, 000	.035267	.004967	....	....	
16, 500	66, 000	.040100	.004833	....	....	
17, 000	68, 000	.045867	.005767	....	....	
17, 500	70, 000	.052233	.006366	.049233	.024300	Micrometer removed.
18, 000	72, 000	.0600	.007767	....	....	
18, 500	74, 000	.0700	.0100	....	....	
19, 000	76, 000	.0867	.0167	....	....	
19, 500	78, 000	.1100	.0233	....	....	
19, 900	79, 600	.1900	.0800	....	....	Ultimate strength.
17, 000	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section ....pounds.. 79, 600
Elastic limit per square inch of original section............................do... 35, 000
Elongation per inch after rupture ....inch.. 0. 24
Elongation per inch under strain at elastic limit............................do... .001233
Reduction in diameter at point of rupture.... ....do... .094
Reduction in area after rupture, per centum of original section............................ 30. 8
Position of rupture ....2″ from middle of stem.
Character of broken surface................granular, 60 per cent.; dull spongy spot at circumference, 40 per cent.

Surface cracks developed on stem.

No. 122.

Tension test.

Marks on bar, B T 3.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set..	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.		0.		Initial load.
1, 250	5, 000	.000233	.000233	0.		
2, 500	10, 000	.000333	.000100	0.		
3, 750	15, 000	.000533	.000200	0.		
5, 000	20, 090	.000633	.000100	0.		
6, 250	25, 000	.000833	.000200	0.		
6, 500	26, 000	.000867	.000034			
6, 750	27, 000	.000900	.000033			
7, 000	28, 000	.000933	.000033			
7, 250	29, 000	.000967	.000034			
7, 500	30, 000	.001000	.000033	.000033	.000033	
7, 750	31, 000	.001000	0.			
8, 000	32, 000	.001067	.000067			
8, 250	33, 000	.001133	.000066			
8, 500	34, 000	.001200	.000067			
8, 750	35, 000	.001267	.000067	.000133	.000100	Elastic limit.
9, 000	36, 000	.001367	.000100			
9, 250	37, 000	.001500	.000133			
9, 500	38, 000	.001667	.000167			
9, 750	39, 000	.003300	.001633	.003667	.003534	
10, 000	40, 000	.004967	.001667			
10, 250	41, 000	.005400	.000433			
10, 500	42, 000	.006667	.001267			
10, 750	43, 000	.007367	.000700			
11, 000	44, 000	.008367	.001000			
11, 250	45, 000	.009067	.000700	.007600	.003933	
11, 500	46, 000	.010000	.000933			
11, 750	47, 000	.010967	.000967			
12, 000	48, 000	.012033	.001066			
12, 250	49, 000	.012933	.000900			
12, 500	50, 000	.014333	.001400	.012500	.004900	Rested under initial load 1 hour.
12, 750	51, 000	.014933	.000600			
13, 000	52, 000	.016267	.001334			
13, 250	53, 900	.017133	.000866			
13, 500	54, 000	.018600	.001467			
13, 750	55, 000	.020000	.001400	.017967	.005467	
14, 000	56, 000	.021333	.001333			
14, 250	57, 000	.022700	.001367			
14, 500	58, 000	.024067	.001367			
14, 750	59, 000	.025967	.001900			
15, 000	60, 000	.027967	.002000	.025500	.007533	
15, 500	62, 000	.031633	.003666			
16, 000	64, 000	.036233	.004600			
16, 500	66, 000	.040967	.004734			
17, 000	68, 000	.046733	[illegible]			
17, 500	70, 000	.054200	[illegible]	.051267	.025797	Micrometer removed.
18, 000	72, 000	.0600	[illegible]			
18, 500	74, 000	.0733	.0133			
19, 000	76, 000	.0867	.0134			
19, 500	78, 000	.1167	.0300			
19, 900	79, 600	.1800	.0633			Ultimate strength.
17, 200						Load at time of fracture.

General summary.

Tensile strength per square inch of original section ....pounds.. 79, 600
Elastic limit per square inch of original section ....do.... 35, 000
Elongation per inch after rupture ....inch.. 0.24
Elongation per inch under strain at elastic limit ....do... .001267
Reduction in diameter at point of rupture ....do... .104
Reduction in area after rupture, per centum of original section 33.6
Position of rupture ....′.5 from middle of stem.
Character of broken surface ....granular, 60 per cent.; dull, spongy, 40 per cent. Surface cracks developed on stem.

No. 127.

Tension test.

Marks on bar, B. L. B.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inches.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000133	.000133	0.	....	
2,500	10,000	.000300	.000167	0.	....	
3,750	15,000	.000400	.000100	0.	....	
5,000	20,000	.000633	.000233	0.	....	
6,250	25,000	.000733	.000100	0.	....	
6,500	26,000	.000767	.000034	....	....	
6,750	27,000	.000833	.000066	....	....	
7,000	28,000	.000867	.000034	....	....	
7,250	29,000	.000933	.000066	....	....	
7,500	30,000	.001000	.000067	0.	....	
7,750	31,000	.001000	0.	....	....	
8,000	32,000	.001033	.000033	....	....	
8,250	33,000	.001067	.000034	....	....	
8,500	34,000	.001100	.000033	....	....	
8,750	35,000	.001100	0.	.000033	.000033	
9,000	36,000	.001133	.000033	....	....	
9,250	37,000	.001200	.000067	....	....	
9,500	38,000	.001267	.000067	....	....	
9,750	39,000	.001333	.000066	....	....	
10,000	40,000	.001367	.000034	.000100	.000067	Elastic limit.
10,250	41,000	.001733	.000366	....	....	
10,500	42,000	.003100	.001367	....	....	
10,750	43,000	.004067	.000967	....	....	
11,000	44,000	.005700	.001633	....	....	
11,250	45,000	.008033	.002333	.006467	.006367	
11,500	46,000	.008767	.000734	....	....	
11,750	47,000	.010000	.001233	....	....	
12,000	48,000	.010633	.000633	....	....	
12,250	49,000	.012000	.001367	....	....	
12,500	50,000	.013000	.001000	.011267	.004800	
12,750	51,000	.014400	.001400	....	....	
13,000	52,000	.015333	.000933	....	....	
13,250	53,000	.016500	.001167	....	....	
13,500	54,000	.017933	.001433	....	....	
13,750	55,000	.019367	.001434	.017300	.006033	
14,000	56,000	.020467	.001100	....	....	
14,250	57,000	.021967	.001500	....	....	
14,500	58,000	.023700	.001733	....	....	
14,750	59,000	.025367	.001667	....	....	
15,000	60,000	.027333	.001966	.024933	.007633	
15,500	62,000	.031267	.003934	....	....	
16,000	64,000	.035900	.004633	....	....	
16,500	66,000	.041267	.005367	....	....	
17,000	68,000	.047667	.006400	....	....	
17,500	70,000	.055600	.007933	.052700	.027767	Micrometer removed.
18,000	72,000	.0667	.0111	....	....	
18,500	74,000	.0833	.0166	....	....	
19,000	76,000	.0967	.0134	....	....	
19,500	78,000	.1500	.0533	....	....	
19,620	78.480	.2000	.0500	....	....	Ultimate strength.
16,000	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds..	78,480
Elastic limit	do....	40,000
Elongation per inch after rupture	inch..	0.32
Elongation per inch under strain at elastic limit	do....	.001367
Reduction in diameter at point of rupture	do....	.194
Reduction in area after rupture, per centum of original section		56.8
Position of rupture		″.5 from middle of stem.
Character of broken surface		silky, spongy, cup-shaped end.

No. 126.

Tension test.

Marks on bar, B. L. T.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

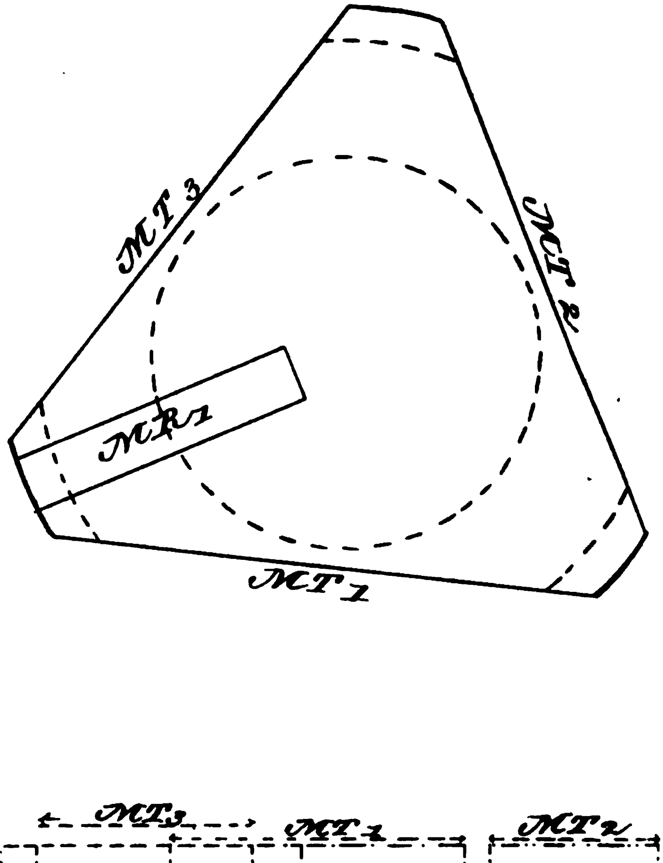
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	....	Initial load.
1, 250	5, 000	.000067	.000067	0.	....	
2, 500	10, 000	.000167	.000100	0.	....	
3, 750	15, 000	.000300	.000133	0.	....	
5, 000	20, 000	.000433	.000133	—.000033	—.000033	
6, 250	25, 000	.000600	.000167	—.000033	0.	
6, 500	26, 000	.000633	.000033	....	....	
6, 750	27, 000	.000667	.000034	....	....	
7, 000	28, 000	.000700	.000033	....	....	
7, 250	29, 000	.000700	0.	....	....	
7, 500	30, 000	.000733	.000033	—.000033	0.	
7, 750	31, 000	.000733	0.	....	....	
8, 000	32, 000	.000767	.000034	....	....	
8, 250	33, 000	.000800	.000033	....	....	
8, 500	34, 000	.000833	.000033	....	....	
8, 750	35, 000	.000867	.000034	—.000033	0.	
9, 000	36, 000	.000933	.000066	....	....	
9, 250	37, 000	.000967	.000034	....	....	
9 500	38, 000	.001000	.000033	....	....	
9, 750	39, 000	.001033	.000033	....	....	
10, 000	40, 000	.001067	.000034	—.000033	0.	
10, 250	41, 000	.001067	0.	....	....	
10, 500	42, 000	.001100	.000033	....	....	
10, 750	43, 000	.001133	.000033	....	....	
11, 000	44, 000	.001133	0.	....	....	
11, 250	45, 000	.001233	.000100	0.	.000033	Elastic limit.
11, 500	46, 000	.005367	.004134	....	....	
11, 750	47, 000	.007567	.002200	....	....	
12, 000	48, 000	.008433	.000866	....	....	
12, 250	49, 000	.009523	.001100	....	....	
12, 500	50, 000	.011067	.001534	.009300	.009267	
12, 750	51, 000	.011433	.000366	....	....	
13, 000	52, 000	.012633	.001200	....	....	
13, 250	53, 000	.013967	.001334	....	....	
13, 500	54, 000	.015100	.001133	....	....	
13, 750	55, 000	.016333	.001233	.014267	.004967	
14, 000	56, 000	.017667	.001334	....	....	
14, 250	57, 000	.018900	.001233	....	....	
14, 500	58, 000	.020667	.001767	....	....	
14, 750	59, 000	.021767	.001100	....	....	
15, 000	60, 000	.023567	.001800	.021333	.007066	
15, 500	62, 000	.027167	.003600	....	....	
16, 000	64, 000	.031333	.004166	....	....	
16, 500	66, 000	.036267	.004934	....	....	
17, 000	68, 000	.042267	.006000	....	....	
17, 500	70, 000	.049033	.006766	.046067	.024734	Micrometer removed.
18, 000	72, 000	.0600	.010967	....	....	
18, 500	74, 000	.0733	.0133	....	....	
19, 000	76, 000	.0900	.0167	....	....	
19, 500	78, 000	.1167	.0267	....	....	
19, 970	79, 880	.1833	.0666	....	....	Ultimate strength.
16, 500	....	....	....	....	....	Load at time of fracture.

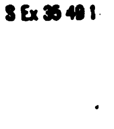
General summary.

Tensile strength per square inch of original section	pounds..	79, 880
Elastic limit per square inch of original section	do....	45, 000
Elongation per inch after rupture	inch ..	0. 397
Elongation per inch under strain at elastic limit	do.,.	.001233
Reduction in diameter at point of rupture	do...	.194
Reduction in area after rupture, per centum of original section		56. 8
Position of rupture		″1 from neck.
Character of broken surface		silky, spongy, cup-shaped end.

8 inch Tube

Muzzle end





No. 130.

Tension test.

Marks on bar, M. R$_1$.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

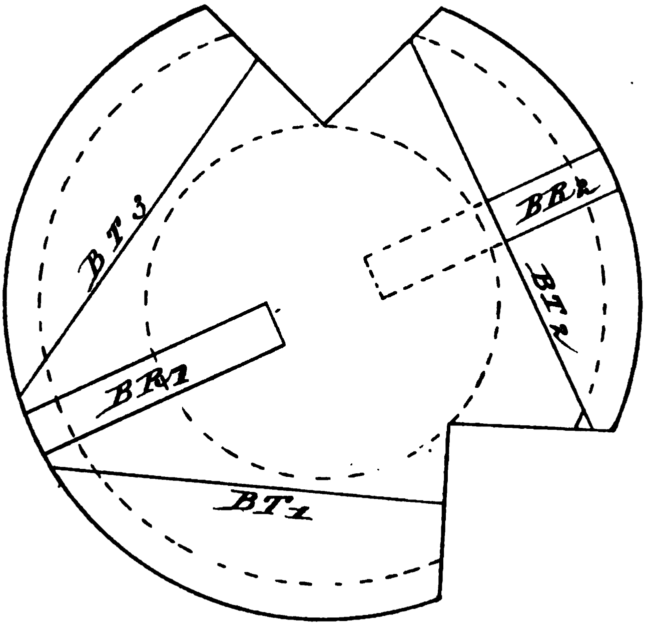
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000100	.000100	0.	....	
2,500	10,000	.000200	.000100	— .000033	— .000033	
3,750	15,000	.000400	.000200	— .000033	0.	
5,000	20,000	.000567	.000167	— .000033	0.	
6,250	25,000	.000767	.000200	0.	.000033	
6,500	26,000	.000800	.000033	....	....	
6,750	27,000	.000833	.000033	....	....	
7,000	28,000	.000867	.000034	....	....	
7,250	29,000	.000900	.000033	....	....	
7,500	30,000	.000900	0.	.000033	.000033	
7,750	31,000	.000933	.000033	....	....	
8,000	32,000	.001000	.000067	....	....	
8,250	33,000	.101067	.000067	....	....	
8,500	34,000	.001100	.000033	....	....	
8,750	35,000	.001133	.000033	.000033	0.	
9,000	36,000	.001133	0.	....	....	
9,250	37,000	.001200	.000067	....	....	
9,500	38,000	.001233	.000033	....	....	
9,750	39,000	.001233	0.	......	......	
10,000	40,000	.001267	.000034	.000067	.000034	Elastic limit.
10,250	41,000	.001367	.000100	....	....	
10,500	42,000	.001467	.000100	....	....	
10,750	43,000	.003633	.002166	....	....	
11,000	44,000	.007867	.004234	....	....	
11,250	45,000	.008433	.000566	.006767	.006700	
11,500	46,000	.008900	.000467	....	....	
11,750	47,000	.009733	.000833	....	....	
12,000	48,000	.010900	.001167	....	....	
12,250	49,000	.011567	.000667	....	....	
12,500	50,000	.012867	.001300	.010900	.004133	
12,750	51,000	.013467	.000600	....	....	
13,000	52,000	.014733	.001266	....	....	
13,250	53,000	.015533	.000800	....	....	
13,500	54,000	.016733	.001200	....	....	
13,750	55,000	.017900	.001167	.015700	.004800	
14,000	56,000	.018867	.000967	....	....	
14,250	57,000	.019900	.001033	....	....	
14,500	58,000	.021500	.001600	....	....	
14,750	59,000	.022800	.001300	....	....	
15,000	60,000	.024200	.001400	.021767	.006067	
15,500	62,000	.027500	.003300	....	....	
16,000	64,000	.030700	.003200	....	....	
16,500	66,000	.034833	.004133	....	....	
17,000	68,000	.039233	.004400	....	....	
17,500	70,000	.044667	.005434	.041533	.019766	Micrometer removed.
18,000	72,000	.0533	.008633	....	....	
18,500	74,000	.0600	.0067	....	....	
19,000	76,000	.0700	.0100	....	....	
19,500	78,000	.0833	.0133	....	....	
20,000	80,000	.0967	.0134	....	....	
20,500	82,000	.1433	.0466	....	....	Ultimate strength.
18,900	....	....	....	....	....	Load at time of fracture.

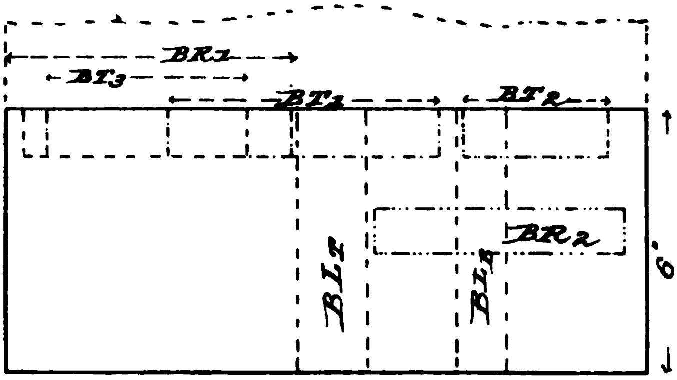
General summary.

Specific gravity, taken from inner end		7.852
Hardness		13.65
Tensile strength per square inch of original section	pounds..	82,000
Elastic limit per square inch of original section	do....	40,000
Elongation per inch after rupture	inch..	0.18
Elongation per inch under strain at elastic limit	do ..	.001267
Reduction in diameter at point of rupture	do...	.124
Reduction in area after rupture, per centum of original section		39.2
Position of rupture		″.4 from neck.
Character of broken surface		granular, 60 per cent.; dull spongy, 40 per cent.

8inch Tube

Breech end





No. 128.

Tension test.

Marks on bar, B. R$_1$.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000167	.000167	.000033	.000033	
2,500	10,000	.000367	.000200	.000033	0.	
3,750	15,000	.000500	.000133	.000033	0.	
5,000	20,000	.000667	.000167	.000033	0.	
6,250	25,000	.000833	.000166	.000067	.000034	
6,500	26,000	.000833	0.	....	....	
6,750	27,000	.000900	.000067	....	....	
7,000	28,000	.000967	.000067	....	....	
7,250	29,000	.001033	.000066	....	....	
7,500	30,000	.001067	.000034	.000133	.000066	
7,750	31,000	.001133	.000066	....	....	
8,000	32,000	.001167	.000034	....	....	
8,250	33,000	.001200	.000033	....	....	Elastic limit.
8,500	34,000	.001300	.000100	....	....	
8,750	35,000	.001467	.000167	.000367	.000234	
9,000	36,000	.001667	.000200	....	....	
9,250	37,000	.002367	.000700	....	....	
9,500	38,000	.003200	.000833	....	....	
9,750	39,000	.004300	.001100	....	....	
10,000	40,000	.005800	.001500	.004400	.004033	
10,250	41,000	.006500	.001300	....	....	
10,500	42,000	.007500	.001000	....	....	
10,750	43,000	.008367	.000867	....	....	
11,000	44,000	.009400	.001033	....	....	
11,250	45,000	.010200	.000800	.008600	.004200	
11,500	46,000	011000	.000800	....	....	
11,750	47,000	.012200	.001200	....	....	
12,000	48,000	.013767	.001567	....	....	
12,250	49,000	.014600	.000833	....	....	
12,500	50,000	.015833	.001233	.013833	.005233	
12,750	51,000	.017333	.001500	....	....	
13,000	52,000	.018767	.001434	....	....	
13,250	53,000	.019700	.000933	....	....	
13,500	54,000	.021400	.001700	....	....	
13,750	55,000	.022700	.001300	.020600	.006767	
14,000	56,000	.024333	.001633	....	....	
14,250	57,000	.026233	.001900	....	....	
14,500	58,000	.028500	.002267	....	....	
14,750	59,000	.029600	.001100	....	....	
15,000	60,000	.032100	.002500	.029667	.009067	
15,500	62,000	.036200	.004100	....	....	
16,000	64,000	.041833	.005633	....	....	
16,500	66,000	.047700	.005867	....	....	
17,000	68,000	.053500	.005800	....	....	
17,500	70,000	.062067	.008567	.059167	.029500	Micrometer removed.
18,000	72,000	.0733	.011233	....	....	
18,500	74,000	.0933	.0200	....	....	
19,000	76,000	.1167	.0234	....	....	
19,380	77,520	.1667	.0500	....	....	Ultimate strength.
18,400	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity, taken from inner end	7.8557
Hardness	11.08
Tensile strength per square inch of original section ....pounds..	77,520
Elastic limit per square inch of original section ....do...	33,000
Elongation per inch after rupture ....inch..	0.20
Elongation per inch under strain at elastic limit ....do...	.001200
Reduction in diameter at point of rupture ....do...	.094
Reduction in area after rupture, per centum of original section	30.8
Position of rupture	″.8 from neck
Character of broken surface	granular, 60 per cent.; dull spot at circumference 40 per cent.; surface cracks developed on stem

No. 129.

Tension test.

Marks on bar, B. R₂.
Length, 3″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	. 000267	. 000267	0.	....	
2, 500	10, 000	. 000433	. 000166	. 000033	. 000033	
3, 750	15, 000	. 000633	. 000200	. 000100	. 000067	
5, 000	20, 000	. 000800	. 000167	. 000133	. 000033	
6, 250	25, 000	. 001000	. 000200	. 000233	. 000100	
6, 500	26, 000	. 001000	0.	....	....	
6, 750	27, 000	. 001067	. 000067	....	....	
7, 000	28, 000	. 001167	. 000100	....	....	
7, 250	29, 000	. 001233	. 000066	....	....	
7, 500	30, 000	. 001300	. 000067	. 000333	. 000100	
7, 750	81, 000	. 001333	. 000033	....	....	
8, 000	32, 000	. 001433	. 000100	....	....	
8, 250	33, 000	. 001533	. 000100	....	....	
8, 500	34, 000	. 001667	. 000134	....	....	
8, 750	35, 000	. 001767	. 000100	. 000667	. 000334	Elastic limit (approximate) not well defined.
9, 000	36, 000	. 002100	. 000333	....	....	
9, 250	37, 000	. 003700	. 001600	....	....	
9, 500	38, 000	. 004767	. 001067	....	....	
9, 750	39, 000	. 005333	. 000566	....	....	
10, 000	40, 000	. 006300	. 000967	. 005000	. 004333	
10, 250	41, 000	. 007033	. 000733	....	....	
10, 500	42, 000	. 007900	. 000867	....	....	
10, 750	43, 000	. 008900	. 001000	....	....	
11, 000	44, 000	. 010133	. 001233	....	....	
11, 250	45, 000	. 011300	. 001167	. 009333	. 004333	
11, 500	46, 000	. 012300	. 001000	....	....	
11, 750	47, 000	. 013333	. 001033	....	....	
12, 000	48, 000	. 014667	. 001334	....	....	
12, 250	49, 000	. 015667	. 001000	....	....	
12, 500	50, 000	. 017333	. 001666	. 015000	. 005667	
12, 750	51, 000	. 017967	. 000634	....	....	
13, 000	52, 000	. 019667	. 001700	....	....	
13, 250	53, 000	. 021000	. 001333	....	....	
13, 500	54, 000	. 022800	. 001800	....	....	
13, 750	55, 000	. 024267	. 001467	. 022033	. 007033	
14, 000	56, 000	. 025733	. 001466	....	....	
14, 250	57, 000	. 027700	. 001967	....	....	
14, 500	58, 000	. 030267	. 002567	....	....	
14, 750	59, 000	. 031367	. 001100	....	....	
15, 000	60, 000	. 033667	. 002300	. 031133	. 009100	
15, 500	62, 000	. 038700	. 005033	....	....	
16, 000	64, 000	. 044067	. 005367	....	....	
16, 500	66, 000	. 050333	. 006266	....	....	
17, 000	68, 000	. 057667	. 007334	....	....	
17, 500	70, 000	. 068000	. 010333	. 064533	. 033400	Micrometer removed.
18, 000	72, 000	. 0867	. 0187	....	....	
18, 500	74, 000	. 1100	. 0233	....	....	
18, 980	75, 920	. 1667	. 0567	....	....	Ultimate strength.
17, 700	....	....	....	....	....	Load at time of fracture.

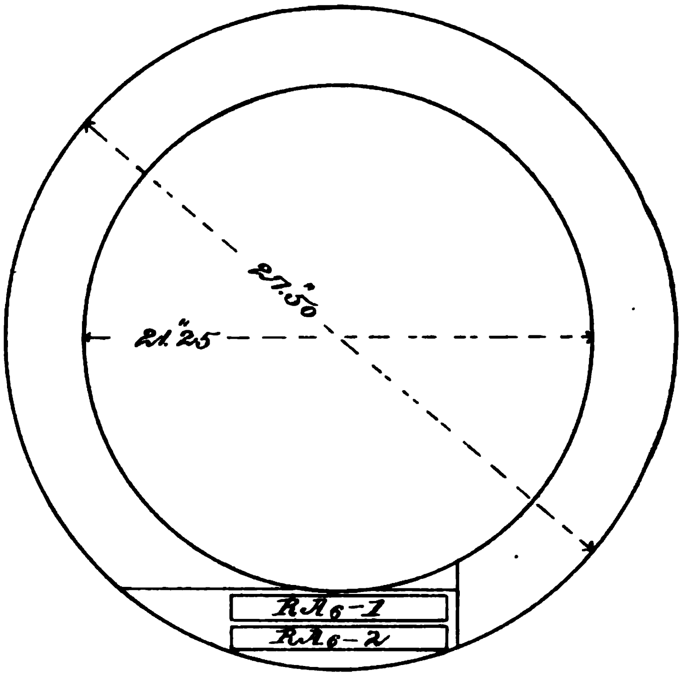
Maximum reduction in diameter was ″.3 from fracture, where it was ″.104.

General summary.

Tensile strength per square inch of original section	pounds..	75, 920
Elastic limit per square inch of original section	do....	35, 000
Elongation per inch after rupture	inch..	0. 217
Elongation per inch under strain at elastic limit	do....	. 001767
Reduction in diameter at point of rupture	do....	. 084
Reduction in area after rupture, per centum of original section		27. 6
Position of rupture		″.4 from middle of stem.
Character of broken surface		granular; small dull spot at circumference; surface cracks developed on stem.

Hoop A6
8 inch Rifle.

Rolled



STEEL FROM HOOPS FOR 8″ B. L. RIFLE.

[From Midvale Steel Works.]

No. 292.

Tension test.

Marks on bar, R. A_6—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000133	.000133	.000017	.000017	
2,500	10,000	.000300	.000167	.000017	0.	
3,750	15,000	.000467	.000167	.000017	0.	
5,000	20,000	.000617	.000150	.000017	0.	
6,250	25,000	.000767	.000150	.000017	0.	
7,500	30,000	.000933	.000166	.000017	0.	
8,750	35,000	.001067	.000134	.000017	0.	
10,000	40,000	.001233	000166	.000017	0.	
10,250	41,000	.001233	0.	....	....	
10,500	42,000	.001283	.000050	....	....	
10,750	43,000	.001333	.000050	....	....	
11,000	44,000	.001367	.000034	....	....	
11,250	45,000	.001383	.000016	.000017	0.	
11,500	46,000	.001400	.000017	....	....	
11,750	47,000	.001417	.000017	....	....	
12,000	48,000	.001450	.000033	....	....	
12,250	49,000	.001500	.000050	....	....	
12,500	50,000	.001533	.000033	.000017	0.	
12,750	51,000	.001583	.000050	....	....	
13,000	52,000	.001617	.000034	....	....	
13,250	53,000	.001633	.000016	....	....	
13,500	54,000	.001667	.000034	....	....	
13,750	55,000	.001700	.000033	.000017	0.	
14,000	56,000	.001733	.000033	....	....	
14,250	57,000	.001767	.000034	....	....	
14,500	58,000	.001800	.000033	....	....	
14,750	59,000	.001850	.000050	....	....	
15,000	60,000	.001883	.000033	.000017	0.	
15,250	61,000	.001917	.000034	....	....	
15,500	62,000	.001950	.000033	....	....	
15,750	63,000	.001983	.000033	....	....	
16,000	64,000	.002017	.000034	....	....	Elastic limit.
16,250	65,000	.002067	.000050	.000067	.000050	
16,500	66,000	.002133	.000066	....	....	
16,750	67,000	.002183	.000050	....	....	
17,000	68,000	.002250	.000067	....	....	
17,250	69,000	.002333	.000083	....	....	
17,500	70,000	.002600	.000267	.000383	.000316	
17,750	71,000	.003050	.000450	....	....	
18,000	72,000	.003983	.000933	....	....	
18,250	73,000	.005433	.001450	....	....	
18,500	74,000	.006650	.001217	....	....	
18,750	75,000	.007317	.000667	.004700	.004317	
19,000	76,000	.008483	.001166	....	....	
19,250	77,000	.009250	.000767	....	....	
19,500	78,000	.010267	.001017	....	....	
17,750	79,000	.011483	.001216	....	....	
20,000	80,000	.012233	.000750	.009200	.004500	Micrometer removed.
20,500	82,000	.0142	.001967	....	....	
21,000	84,000	.0158	.0016	....	....	
21,500	86,000	.0175	.0017	....	....	
22,000	88,000	.0200	.0025	....	....	
22,500	90,000	.0225	.0025	....	....	
23,000	92,000	.0250	.0025	....	....	
23,500	94,000	.0283	.0033	....	....	
24,000	96,000	.0308	.0025	....	....	
24,500	98,000	.0342	.0034	....	....	
25,000	100,000	.0383	.0041	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
25,500	102,000	.0433	.0050	....	....	
26,000	104,000	.0492	.0059	....	....	
26,500	106,000	.0600	.0108	....	....	
27,000	108,000	.0733	.0133	....	....	
27,320	109,280	.0983	.0256	....	....	Ultimate strength.
21,900	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity	7.86
Hardness	23.30
Tensile strength per square inch of original section ... pounds	109,2
Elastic limit ... do	64,0
Elongation per inch after rupture ... inch	.14
Elongation per inch under strain at elastic limit ... do	.00
Reduction in diameter at point of rupture ... do	.174
Reduction in area after rupture, per centum of original section	52.4
Position of rupture	".9 from neck
Character of broken surface	silky, interspersed with fine granular meta
Elongation of inch sections	".09, ".09, ".09, ".11, ".12 (".34 fractured sectio

No. 293.

Tension test.

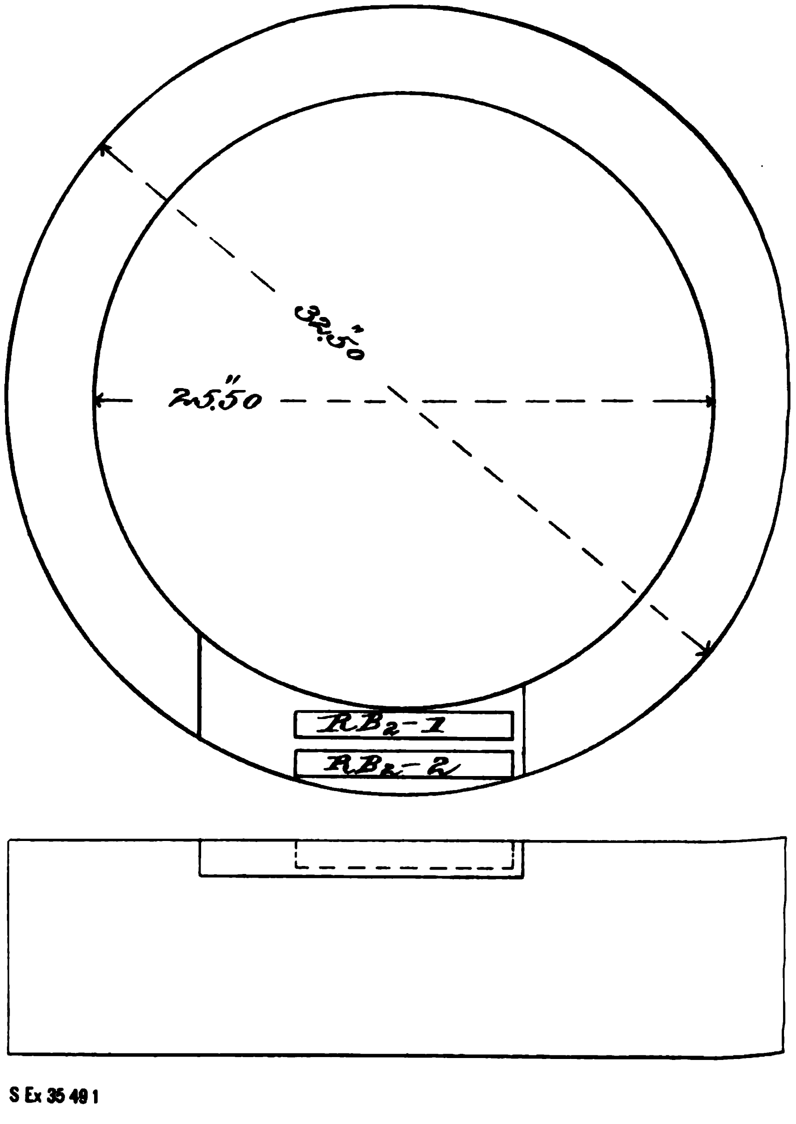
Marks on bar, R.A. $_6$—2.
Length, 6".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000167	.000167	0.	....	
2,500	10,000	.000333	.000166	0.	....	
3,750	15,000	.000433	.000100	0.	....	
5,000	20,000	.000583	.000150	0.	....	
6,250	25,000	.000750	.000167	0.	....	
7,500	30,000	.000917	.000167	0.	....	
8,750	35,000	.001067	.000150	0.	....	
10,000	40,000	.001233	.000166	0.	....	
10,250	41,000	.001250	.000017	....	....	
10,500	42,000	.001300	.000050	....	....	
10,750	43,000	.001333	.000033	....	....	
11,000	44,000	.001383	.000050	....	....	
11,250	45,000	.001400	.000017	0.	....	
11,500	46,000	.001400	0.	....	....	
11,750	47,000	.001433	.000033	....	....	
12,000	48,000	.001467	.000034	....	....	
12,250	49,000	.001500	.000033	....	....	
12,500	50,000	.001517	.000017	0.	....	
12,750	51,000	.001583	.000066	....	....	
13,000	52,000	.001633	.000050	....	....	
13,250	53,000	.001650	.000017	....	....	
13,500	54,000	.001667	.000017	....	....	
13,750	55,000	.001683	.000016	0.	....	
14,000	56,000	.001750	.000067	....	....	
14,250	57,000	.001767	.000017	....	....	
14,500	58,000	.001783	.000016	....	....	
14,750	59,000	.001800	.000017	....	....	
15,000	60,000	.001867	.000067	0.	....	
15,250	61,000	.001900	.000033	....	....	

Hoop B_2

8 inch Rifle

Rolled



Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
15, 500	62, 000	.001950	.000050	....	....	
15, 750	63, 000	.001967	.000017	....	....	
16, 000	64, 000	.002000	.000033	....	....	
16, 250	65, 000	.002050	.000050	.000017	.000017	
16, 500	66, 000	.002083	.000033	....	....	
16, 750	67, 000	.002133	.000050	....	....	Elastic limit.
17, 000	68, 000	.002283	.000100	....	....	
17, 250	69, 000	.002400	.000167	....	....	
17, 500	70, 000	.004000	.001600	.001667	.001650	
17, 750	71, 000	.004983	.000983	....	....	
18, 000	72, 000	.006250	.001267	....	....	
18, 250	73, 000	.007083	.000833	....	....	
18, 500	74, 000	.008367	.001284	....	....	
18, 750	75, 000	.009100	.000733	.006333	.004666	
19, 000	76, 000	.009733	.000633	....	....	
19, 250	77, 000	.010650	.000917	....	....	
19, 500	78, 000	.011817	.001167	....	....	
19, 750	79, 000	.012567	.000750	....	....	
20, 000	80, 000	.013733	.001166	.010667	.004334	Micrometer removed.
20, 500	82, 000	.0150	.001267	....	....	
21, 000	84, 000	.0183	.0033	....	....	
21, 500	86, 000	.0200	.0017	....	....	
22, 000	88, 000	.0225	.0025	....	....	
22, 500	90, 000	.0250	.0025	....	....	
23, 000	92, 000	.0275	.0025	....	....	
23, 500	94, 000	.0308	.0033	....	....	
24, 000	96, 000	.0342	.0034	....	....	
24, 500	98, 000	.0392	.0050	....	....	
25, 000	100, 000	.0433	.0041	....	....	
25, 500	102, 000	.0500	.0067	....	....	
26, 000	104, 000	.0567	.0067	....	....	
26, 500	106, 000	.0650	.0083	....	....	
27, 000	108, 000	.0967	.0317	....	....	Ultimate strength.
20, 800	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section	pounds	108, 000
Elastic limit per square inch of original section	do	67, 000
Elongation per inch after rupture	inch	0. 153
Elongation per inch under strain at elastic limit	do	.002133
Reduction in diameter at point of rupture	do	.194
Reduction in area after rupture, per centum of original section		56. 8
Position of rupture		1″.2 from neck
Character of broken surface		silky, interspersed with fine granular metal
Elongation of inch sections		″.08, ″.09, ″.11, ″.13, ″.23 (″.28 fractured section)

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
27,500	110,000	.0517	.0067			
28,000	112,000	.0600	.0083			
28,500	114,000	.0750	.0150			Ultimate strength.
26,100						Load at time of fracture.

General summary.

Specific gravity 7.8615
Hardness 24.26
Tensile strength per square inch of original section .... pounds .. 114,000
Elastic limit per square inch of original section .... do ... 65,000
Elongation per inch after rupture .... inch .. 0.103
Elongation per inch under strain at elastic limit .... do ... .002000
Reduction in diameter at point of rupture .... do ... .104
Reduction in area after rupture, per centum of original section 33.6
Position of rupture .... 1″ from neck.
Character of broken surface .... granular, small dull spot ″.08 eccentric.
Elongation of inch sections .... ″.07, ″.06, ″.06, ″.06, ″.12 (″.25 fractured section).

No. 294.

Tension test.

Marks on bar, R. B.$_2$—2.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.		0.		Initial load.
1,250	5,000	.000083	.000083	0.		
2,500	10,000	.000250	.000167	0.		
3,750	15,000	.000400	.000150	0.		
5,000	20,000	.000567	.000167	0.		
6,250	25,000	.000733	.000166	0.		
7,500	30,000	.000900	.000167	0.		
8,750	35,000	.001050	.000150	0.		
10,000	40,000	.001217	.000167	0.		
10,250	41,000	.001217	0.			
10,500	42,000	.001233	.000016			
10,750	43,000	.001283	.000050			
11,000	44,000	.001317	.000034			
11,250	45,000	.001350	.000033	0.		
11,500	46,000	.001383	.000033			
11,750	47,000	.001400	.000017			
12,000	48,000	.001450	.000050			
12,250	49,000	.001483	.000033			
12,500	50,000	.001500	.000017	0.		
12,750	51,000	.001550	.000050			
13,000	52,000	.001583	.000033			
13,250	53,000	.001617	.000034			
13,500	54,000	.001650	.000033			
13,750	55,000	.001683	.000033	.000033	.000033	
14,000	56,000	.001733	.000050			
14,250	57,000	.001767	.000034			
14,500	58,000	.001800	.000033			
14,750	59,000	.001850	.000050			
15,000	60,000	.001900	.000050	.000050	.000017	
15,250	61,000	.001967	.000067			Elastic limit.
15,500	62,000	.002033	.000066			
15,750	63,000	.002117	.000084			

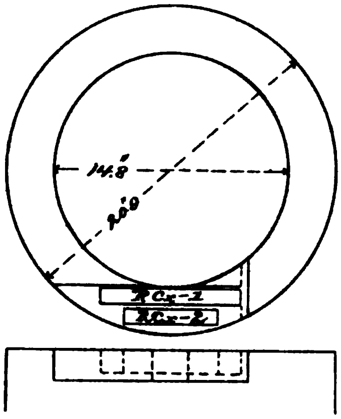
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16, 000	64, 000	.002283	.000166	....	....	
16, 250	65, 000	.002450	.000167	.000383	.000333	
16, 500	66, 000	.002717	.000267	....	....	
16, 750	67, 000	.002983	.000266	....	....	
17, 000	68, 000	.003517	.000534	....	....	
17, 250	69, 000	.004100	.000583	....	....	
17, 500	70, 000	.005117	.001017	.002717	.002334	
17, 750	71, 000	.005500	.000383	....	....	
18, 000	72, 000	.006250	.000750	....	....	
18, 250	73, 000	.006917	.000667	....	....	
18, 500	74, 000	.008000	.001083	....	....	
18, 750	75, 000	.009000	.001000	.006267	.003550	
19, 000	76, 000	.009600	.000600	....	....	
19, 250	77, 000	.010167	.000567	....	....	
19, 500	78, 000	.011133	.000966	....	....	
19, 750	79, 000	.012100	.000967	....	....	
20, 000	80, 000	.013100	.001000	.010083	.003816	Micrometer removed.
20, 500	82, 000	.0142	.0011	....	....	
21, 000	84, 000	.0167	.0025	....	....	
21, 500	86, 000	.0183	.0016	....	....	
22, 000	88, 000	.0200	.0017	....	....	
22, 500	90, 000	.0233	.0033	....	....	
23, 000	92, 000	.0250	.0017	....	....	
23, 500	94, 000	.0275	.0025	....	....	
24, 000	96, 000	.0308	.0033	....	....	
24, 500	98, 000	.0342	.0034	....	....	
25, 000	100, 000	.0375	.0033	....	....	
25, 500	102, 000	.0408	.0033	....	....	
26, 000	104, 000	.0467	.0059	....	....	
26, 500	106, 000	.0533	.0066	....	....	
27, 000	108, 000	.0700	.0167	....	....	
27, 500	110, 000	.0750	.0050	....	....	
28, 000	112, 000	.1067	.0317	....	....	Ultimate strength.
26, 300	....	....	....	....	....	Load at time of fracture.

General summary.

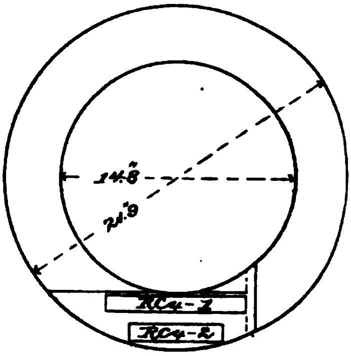
Tensile strength per square inch of original section..................................pounds.. 112, 000
Elastic limit per square inch of original section..................................do.... 61, 000
Elongation per inch after rupture..................................inch... 0. 147
Elongation per inch under strain at elastic limit..................................do.... .001967
Reduction in diameter at point of rupture..................................do.... .084
Reduction in area after rupture, per centum of original section..................................27. 6
Position of rupture..................................".85 from neck.
Character of broken surface..................................granular, dull spot ".05 eccentric.
Elongation of inch sections..................................".15, ".14, ".12, ".12, ".13 (".22 fractured section).

Hoops C4, Cx, Dx
8 inch Rifle

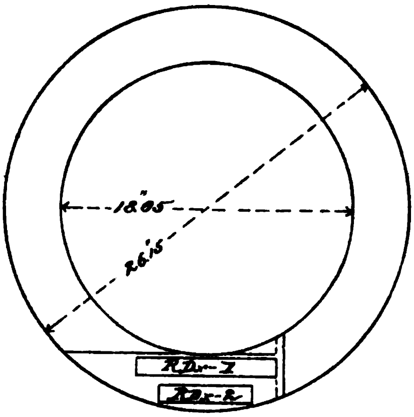
Cx
Hammered



C4
Hammered.

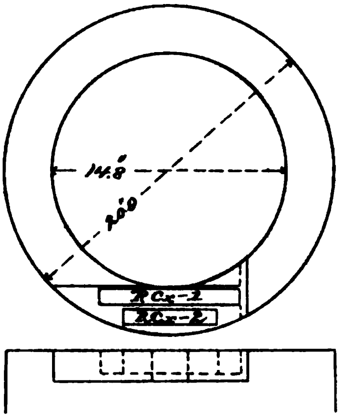


Dx
Hammered

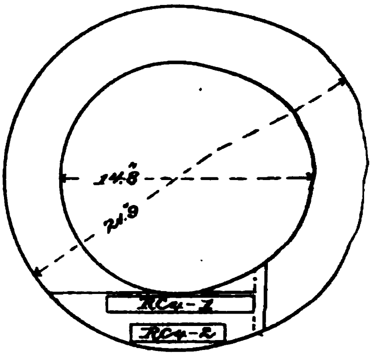


Hoops C4, Cx, Dx
8 inch Rifle

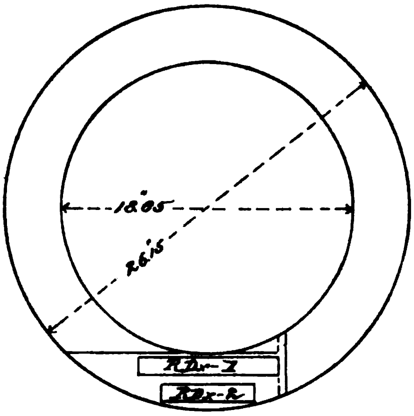
Cx
Hammered



C4
Hammered.



Dx
Hammered



S Ex 35 49 1

No. 290.

Tension test.

Marks on bar, R. C.$_4$—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000150	.000150	.000017	.000017	
2,500	10,000	.000317	.000167	.000017	0.	
3,750	15,000	.000467	.000150	.000017	0.	
5,000	20,000	.000583	.000116	.000017	0.	
6,250	25,000	.000733	.000150	.000017	0.	
7,500	30,000	.000900	.000167	.000017	0.	
8,750	35,000	.001067	.000167	.000017	0.	
10,000	40,000	.001233	.000166	.000017	0.	
10,250	41,000	.001250	.000017	....	....	
10,500	42,000	.001283	.000033	....	....	
10,750	43,000	.001317	.000034	....	....	
11,000	44,000	.001350	.000033	....	....	
11,250	45,000	.001350	0.	.000017	0.	
11,500	46,000	.001400	.000050	....	....	
11,750	47,000	.001417	.000017	....	....	
12,000	48,000	.001450	.000033	....	....	
12,250	49,000	.001483	.000033	....	....	
12,500	50,000	.001517	.000034	.000017	0.	
12,750	51,000	.001567	.000050	....	....	
13,000	52,000	.001583	.000016	....	....	
13,250	53,000	.001617	.000034	....	....	
13,500	54,000	.001650	.000033	....	....	
13,750	55,000	.001683	.000033	.000017	0.	
14,000	56,000	.001733	.000050	....	....	
14,250	57,000	.001750	.000017	....	....	
14,500	58,000	.001783	.000033	....	....	
14,750	59,000	.001833	.000050	....	....	
15,000	60,000	.001867	.000034	.000017	0.	
15,250	61,000	.001900	.000033	....	....	
15,500	62,000	.001917	.000017	....	....	
15,750	63,000	.001950	.000033	....	....	
16,000	64,000	.001983	.000033	....	....	
16,250	65,000	.002033	.000050	.000050	.000033	
16,500	66,000	.002067	.000034	....	....	
16,750	67,000	.002100	.000033	....	....	Elastic limit.
17,000	68,000	.002150	.000050	....	....	
17,250	69,000	.002283	.000133	....	....	
17,500	70,000	.002633	.000350	.000400	.000350	
17,750	71,000	.002933	.000300	....	....	
18,000	72,000	.003550	.000617	....	....	
18,250	73,000	.004417	.000867	....	....	
18,500	74,000	.005317	.000900	....	....	
18,750	75,000	.006000	.000683	.003317	.002917	
19,000	76,000	.006650	.000650	....	....	
19,250	77,000	.007050	.000400	....	....	
19,500	78,000	.007933	.000883	....	....	
19,750	79,000	.008550	.000617	....	....	
20,000	80,000	.009600	.001050	.006600	.003283	Micrometer removed.
20,500	82,000	.0108	.0012	....	....	
21,000	84,000	.0125	.0017	....	....	
21,500	86,000	.0142	.0017	....	....	
22,000	88,000	.0158	.0016	....	....	
22,500	90,000	.0175	.0017	....	....	
23,000	92,000	.0192	.0017	....	....	
23,500	94,000	.0217	.0025	....	....	
24,000	96,000	.0233	.0016	....	....	
24,500	98,000	.0250	.0017	....	....	
25,000	100,000	.0283	.0033	....	....	
25,500	102,000	.0308	.0025	....	....	
26,000	104,000	.0325	.0017	....	....	
26,500	106,000	.0350	.0025	....	....	
27,000	108,000	.0400	.0050	....	....	
27,500	110,000	.0442	.0042	....	....	

No. 288.

Tension test.

Marks on bar, R. C_x—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	....	0.	....	Initial load.
1,250	5,000	.000117	.000117	.000033	.000033	
2,500	10,000	.000350	.000233	.000100	.000067	
3,750	15,000	.000500	.000150	.000117	.000017	
5,000	20,000	.000650	.000150	.000133	.000016	
6,250	25,000	.000817	.000167	.000150	.000017	
7,500	30,000	.001017	.000200	.000150	0.	
8,750	35,000	.001117	.000100	.000133	.000017	
10,000	40,000	.001267	.000150	.000133	0.	
10,250	41,000	.001283	.000016	....	....	
10,500	42,000	.001317	.000034	....	....	
10,750	43,000	.001350	.000033	....	....	
11,000	44,000	.001383	.000033	....	....	
11,250	45,000	.001417	.000034	.000133	0.	
11,500	46,000	.001483	.000066	....	....	
11,750	47,000	:001517	.000034	....	....	
12,000	48,000	.001550	.000033	....	....	
12,250	49,000	.401583	.000033	....	....	
12,500	50,000	.001617	.000034	.000133	0.	
12,750	51,000	.001633	.000016	....	....	
13,000	52,000	.001700	.000067	....	....	
13,250	53,000	.001717	.000017	....	....	
13,500	54,000	.001733	.000016	....	....	
13,750	55,000	.001750	.000017	.000133	0.	
14,000	56,000	.001800	.000050	....	....	
14,250	57,000	.001833	.000033	....	....	
14,500	58,000	.001867	.000034	....	....	
14,750	59,000	.001917	.000050	....	....	
15,000	60,000	.001950	.000033	.000133	0.	
15,250	61,000	.001983	.000033	....	....	
15,500	62,000	.002017	.000034	....	....	
15,750	63,000	.002050	.000033	....	....	Elastic limit.
16,000	64,000	.002100	.000050	....	....	
16,250	65,000	.002183	.000083	.000200	.000067	
16,500	66,000	.002283	.000100	....	....	
16,750	67,000	.002450	.000167	....	....	
17,000	68,000	.002733	.000283	....	....	
17,250	69,000	.002983	.000250	....	....	
17,500	70,000	.003400	.000417	.001100	.000900	
17,750	71,000	.003867	.000467	....	....	
18,000	72,000	.004533	.000666	....	....	
18,250	73,000	.005117	.000584	....	....	
18,500	74,000	.006033	.000916	....	....	
18,750	75,000	.006550	.000517	.003867	.002767	
19,000	76,000	.007200	.000650	....	....	
19,250	77,000	.008033	.000833	....	....	
19,500	78,000	.008883	.000850	....	....	
19,750	79,000	.009700	.000817	....	....	
20,000	80,000	.010667	.000967	.007700	.003833	Micrometer removed.
20,500	82,000	.0117	.001033	....	....	
21,000	84,000	.0133	.0016	....	....	
21,500	86,000	.0167	.0034	....	....	
22,000	88,000	.0183	.0016	....	....	
22,500	90,000	.0200	.0017	....	....	
23,000	92,000	.0225	.0025	....	....	
23,500	94,000	.0250	.0025	....	....	
24,000	96,000	.0267	.0017	....	....	
24,500	98,000	.0283	.0016	....	....	
25,000	100,000	.0317	.0034	....	....	
25,500	102,000	.0342	.0025	....	....	
26,000	104,000	.0375	.0033	....	....	
26,500	106,000	.0408	.0033	....	....	
27,000	108,000	.0467	.0059	....	....	
27,500	110,000	.0500	.0033	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28, 000	112, 000	.0583	.0083	....	....	
28, 500	114, 000	.0667	.0084	....	....	
28, 970	115, 880	.0917	.0250	....	....	Ultimate strength.
25, 800	....	....	....	....	....	Load at time of fracture.

General summary.

Specific gravity 7.8616
Hardness 23.70
Tensile strength per square inch of original section .... pounds.. 115, 880
Elastic limit per square inch of original section .... do ... 63, 000
Elongation per inch after rupture .... inch.. 0.10
Elongation per inch under strain at elastic limit .... do.... .002050
Reduction in diameter at point of rupture .... do.... .114
Reduction in area after rupture, per centum of original section 36.4
Position of rupture .... ".65 from neck.
Character of broken surface....... granular, radiating from a dull spot at center of fractured surface.
Elongation of inch sections .... ".07, ".06, ".06, ".07, ".08 (".26 fractured section).

No. 296.

Tension test.

Marks on bar, R. C_x—2.
Length, 3".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
1, 250	5, 000	.000133	.000133	0.	....	
2, 500	10, 000	.000333	.000200	0.	....	
3, 750	15, 000	.000433	.000100	0.	....	
5, 000	20, 000	.000667	.000234	0.	....	
6, 250	25, 000	.000700	.000033	0.	....	
7, 500	30, 000	.000933	.000233	0.	....	
8, 750	35, 000	.001033	.000100	0.	....	
10, 000	40, 000	.001233	.000200	0.	....	
10, 250	41, 000	.001233	0.	....	....	
10, 500	42, 000	.001267	.000034	....	....	
10, 750	43, 000	.001300	.000033	....	....	
11, 000	44, 000	.001300	0.	....	....	
11, 250	45, 000	.001367	.000067	0.	....	
11, 500	46, 000	.001400	.000033	....	....	
11, 750	47, 000	.001433	.000033	....	....	
12, 000	48, 000	.001433	0.	....	....	
12, 250	49, 000	.001467	.000034	....	....	
12, 500	50, 000	.001467	0.	0.	....	
12, 750	51, 000	.001500	.000033	....	....	
13, 000	52, 000	.001533	.000033	....	....	
13, 250	53, 000	.001567	.000034	....	....	
13, 500	54, 000	.001600	.000033	....	....	
13, 750	55, 000	.001633	.000033	0.	....	
14, 000	56, 000	.001733	.000100	....	....	
14, 250	57, 000	.001767	.000034	....	....	
14, 500	58, 000	.001800	.000033	....	....	
14, 750	59, 000	.001800	0.	....	....	
15, 000	60, 000	.001833	.000033	0.	....	
15, 250	61, 000	.001900	.000067	....	....	
15, 500	62, 000	.001933	.090033	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
15, 750	63, 000	.001967	.000034	....	....	
16, 000	64, 000	.002000	.000033	....	....	
16, 250	65, 000	.002033	.000033	0.	....	Elastic limit.
16, 500	66, 000	.002233	.000200	....	....	
16, 750	67, 000	.002500	.000267	....	....	
17, 000	68, 000	.003033	.000533	....	....	
17, 250	69, 000	.003667	.000634	....	....	
17, 500	70, 000	.004433	.000766	.002067	.002067	
17, 750	71, 000	.005033	.000600	....	....	
18, 000	72, 000	.005667	.000634	....	....	
18, 250	73, 000	.006333	.000666	....	....	
18, 500	74, 000	.007300	.000967	....	....	
18, 750	75, 000	.008100	.000800	.005367	.003300	
19, 000	76, 000	.008800	.000700	....	....	
19, 250	77, 000	.009367	.000567	....	....	
19, 500	78, 000	.010433	.001066	....	....	
19, 750	79, 000	.011067	.000634	....	....	
20, 000	80, 000	.012367	.001300	.009333	.003966	
20, 500	82, 000	.014033	.001666	....	....	
21, 000	84, 000	.015733	.001700	....	....	
21, 500	86, 000	.017833	.002100	....	....	
22, 000	88, 000	.019900	.002067	....	....	
22, 500	90, 000	.022100	.002200	....	....	
23, 000	92, 000	.024100	.002000	....	....	
23, 500	94, 000	.026700	.002600	....	....	
24, 000	96, 000	.029000	.002300	....	....	
24, 500	98, 000	.032100	.003100	....	....	
25, 000	100, 000	.035200	.003100	....	....	
25, 500	102, 000	.038367	.003167	....	....	
26, 000	104, 000	.043033	.004666	....	....	
26, 500	106, 000	.047500	.004467	....	....	
27, 000	108, 000	.051667	.004167	....	....	Micrometer removed.
27, 500	110, 000	.0567	.005033	....	....	
28, 000	112, 000	.0750	.0183	....	....	
28, 500	114, 000	.0967	.0217	....	....	
28, 620	114, 480	.1167	.0200	....	....	Ultimate strength.
24, 900	....	....	....	....	....	Load at time of fracture.

General summary.

Tensile strength per square inch of original section ....pounds..	114,480
Elastic limit per square inch of original section ....do....	65,000
Elongation per inch after rupture ....inch..	0.167
Elongation per inch under strain at elastic limit ....do....	.002033
Reduction in diameter at point of rupture...do....	.124
Reduction in area after rupture, per centum of original section..........................	39.2
Position of rupture	1″ from neck.
Character of broken surface	granular, dull smoky center.
Elongation of inch sections..	″.09 ″.14 (″.27 fractured sections).

No. 291.

Tension test.

Marks on bar, R. D$_x$—1.
Length, 6″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.		0.		Initial load.
1, 250	5, 000	.000117	.000117	0.		
2, 500	10, 000	.000283	.000166	0.		
3, 750	15, 000	.000450	.000167	0.		
5, 000	20, 000	.000600	.000150	0.		
6, 250	25, 000	.000733	.000133	0.		
7, 500	30, 000	.000900	.000167	0.		
8, 750	35, 000	.001050	.000150	0.		
10, 000	40, 000	.001183	.000133	0.		
10, 250	41, 000	.001217	.000034			
10, 500	42, 000	.001267	.000050			
10, 750	43, 000	.001300	.000033			
11, 000	44, 000	.001333	.000033			
11, 250	45, 000	.001367	.000034	0.		
11, 500	46, 000	.001383	.000016			
11, 750	47, 000	.001417	.000034			
12, 000	48, 000	.001450	.000033			
12, 250	49, 000	.001500	.000050			
12, 500	50, 000	.001550	.000050	0.		
12, 750	51, 000	.001567	.000017			
13, 000	52, 000	.001583	.000016			
13, 250	53, 000	.001600	.000017			
13, 500	54, 000	.001633	.000033			
13, 750	55, 000	.001667	.000034	0.		
14, 000	56, 000	.001717	.000050			
14, 250	57, 000	.001733	.000016			
14, 500	58, 000	.001767	.000034			
14, 750	59, 000	.001800	.000033			
15, 000	60, 000	.001833	.000033	0.		
15, 250	61, 000	.001883	.000050			
15, 500	62, 000	.001917	.000034			
15, 750	63, 000	.001950	.000033			
16, 000	64, 000	.001983	.000033			
16, 250	65, 000	.002017	.000034	.000017	.000017	
16, 500	66, 000	.002100	.000083			
16, 750	67, 000	.002133	.000033			
17, 000	68, 000	.002167	.000034			Elastic limit.
17, 250	69, 000	.002317	.000150			
17, 500	70, 000	.002517	.000200	.000317	.000300	
17, 750	71, 000	.002700	.000183			
18, 000	72, 000	.003083	.000383			
18, 250	73, 000	.003450	.000364			
18, 500	74, 000	.004033	.000583			
18, 750	75, 000	.004667	.000634	.002083	.001766	
19, 000	76, 000	.005167	.000500			
19, 250	77, 000	.005583	.000366			
19, 500	78, 000	.006117	.000584			
19, 750	79, 000	.006817	.000700			
20, 000	80, 000	.007700	.000883	.004750	.002667	Micrometer removed.
20, 500	82, 000	.0083	.0006			
21, 000	84, 000	.0100	.0017			
21, 500	86, 000	.0117	.0017			
22, 000	88, 000	.0133	.0016			
22, 500	90, 000	.0142	.0009			
23, 000	92, 000	.0158	.0016			
23, 500	94, 000	.0175	.0017			
24, 000	96, 000	.0192	.0017			
24, 500	98, 000	.0208	.0016			
25, 000	100, 000	.0233	.0025			
25, 500	102, 000	.0250	.0017			
26, 000	104, 000	.0275	.0025			
26, 500	106, 000	.0292	.0017			
27, 000	108, 000	.0325	.0033			
27, 500	110, 000	.0350	.0025			
28, 000	112, 000	.0383	.0033			

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
28, 500	114, 000	.0417	.0034			
29, 000	116, 000	.0450	.0033			
29, 500	118, 000	.0533	.0083			
30, 000	120, 000	.617	.0084			
30, 500	122, 000	0783	.0166			
30, 580	122, 320	.1000	.0217			Ultimate strength.
28, 100						Load at time of fracture.

General summary.

Specific gravity	7.850
Hardness	26.51
Tensile strength per square inch of original section ... pounds..	122,320
Elastic limit per square inch of original section ... do....	68,000
Elongation per inch after rupture ... inch..	0.107
Elongation per inch under strain at elastic limit ... do....	.00216
Reduction in diameter at point of rupture ... do....	.094
Reduction in area after rupture, per centum of original section	30.8
Position of rupture	".6 from sect.
Character of broken surface	granular, radiating from a dull spot at center of fractured surface.
Elongation of inch sections	".07, ".09, ".09, ".08, ".09 (".22 fractured section).

No. 297.

Tension test.

Marks on bar, R. D_x—2.
Length, 3".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.		0.		**Initial load.**
1, 250	5, 000	.000067	.000067	0.		
2, 500	10, 000	.000267	.000200	0.		
3, 750	15, 000	.000433	.000166	0.		
5, 000	20, 000	.000633	.000200	0.		
6, 250	25, 000	.000767	.000134	0.		
7, 500	30, 000	.000967	.000200	0.		
8, 750	35, 000	.001033	.000066	0.		
10, 000	40, 000	.001233	.000200	0.		
10, 250	41, 000	.001267	.000034			
10, 500	42, 000	.001300	.000033			
10, 750	43, 000	.001333	.000033			
11, 000	44, 000	.001367	.000034			
11, 250	45, 000	.001400	.000033	0.		
11, 500	46, 000	.001400	0.			
11, 750	47, 000	.001433	.000033			
12, 000	48, 000	.001467	.000034			
12, 250	49, 000	.001500	.000033			
12, 500	50, 000	.001500	0.	0.		
12, 750	51, 000	.001567	.000067			
13, 000	52, 000	.001600	.000033			
13, 250	53, 000	.001633	.000033			
13, 500	54, 000	.001667	.000034			
13, 750	55, 000	.001700	.000033	0.		
14, 000	56, 000	.001767	.000067			
14, 250	57, 000	.001800	.000033			
14, 500	58, 000	.001833	.000033			
14, 750	59, 000	.001867	.000034			

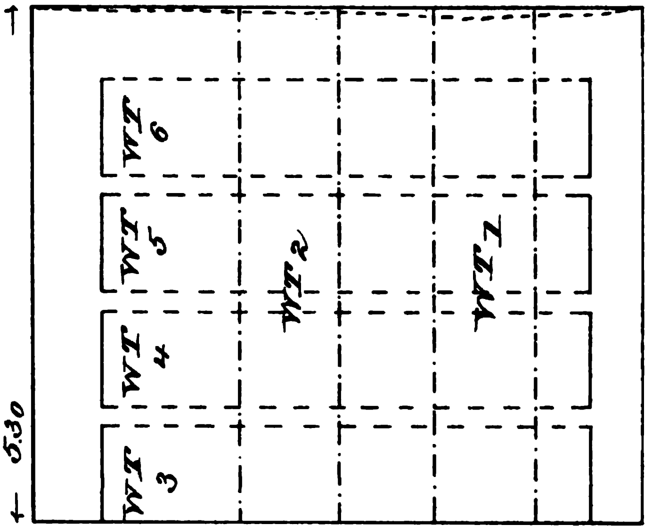
Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
15,000	60,000	.001900	.000033	0.	....	
15,250	61,000	.001933	.000033	....	....	
15,500	62,000	.001967	.000034	....	....	
15,750	63,000	.002000	.000033	....	....	
16,000	64,000	.002033	.000033	....	....	
16,250	65,000	.002067	.000034	.000033	.000033	
16,500	66,000	.002167	.000100	....	....	
16,750	67,000	.002200	.000033	....	....	
17,000	68,000	.002233	.000033	....	....	
17,250	69,000	.002300	.000067	....	....	Elastic limit.
17,500	70,000	.002600	.000300	.000400	.000367	
17,750	71,000	.002867	.000267	....	....	
18,000	72,000	.003400	.000533	....	....	
18,250	73,000	.003767	.000367	....	....	
18,500	74,000	.004500	.000733	....	....	
18,750	75,000	.004867	.000367	.002300	.001900	
19,000	76,000	.005567	.000700	....	....	
19,250	77,000	.005933	.000366	....	....	
19,500	78,000	.006600	.000667	....	....	
19,750	79,000	.007033	.000433	....	....	
20,000	80,000	.007833	.000400	.005033	.002733	
20,500	82,000	.009267	.001434	....	....	
21,000	84,000	.010567	.001300	....	....	
21,500	86,000	.012200	.001633	....	....	
22,000	88,000	.013533	.001333	....	....	
22,500	90,000	.015067	.001534	....	....	
23,000	92,000	.016533	.001466	....	....	
23,500	94,000	.017867	.001334	....	....	
24,000	96,000	.019533	.001666	....	....	
24,500	98,000	.021200	.001667	....	....	
25,000	100,000	.023200	.002000	....	....	
25,500	102,000	.025100	.001900	....	....	
26,000	104,000	.027433	.002333	....	....	
26,500	106,000	.029767	.002334	....	....	
27,000	108,000	.032100	.002333	....	....	
27,500	110,000	.035167	.003067	....	....	
28,000	112,000	.038267	.003100	....	....	
28,500	114,000	.042600	.004333	....	....	Micrometer removed.
29,000	116,000	.0500	.0074	....	....	
29,500	118,000	.0567	.0067	....	....	
30,000	120,000	.0633	.0066	....	....	
30,500	122,000	.0800	.0167	....	....	
30,850	123,400	.1133	.0333	....	....	Ultimate strength.
27,500	....	....	....	....	....	Load at time of fracture.

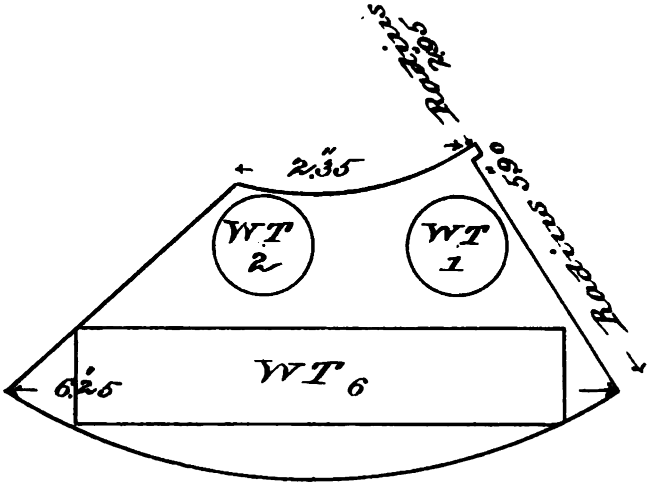
General summary.

Tensile strength per square inch of original section....................pounds.. 123,400
Elastic limit per square inch of original section....................do ... 69,000
Elongation per inch after rupture....................inch.. 0.15
Elongation per inch under strain at elastic limit....................do... .002300
Reduction in diameter at point of rupture....................do... .104
Reduction in area after rupture, per centum of original section.................... 33.6
Position of rupture....................".9 from neck.
Character of broken surface....................granular, dull smoky center.
Elongation of inch sections....................".09 ".13 (".23 fractured section).

WHITWORTH STEEL FROM TUBE OF MANN GUN.

Whitworth steel
from Tube of Mann gun





No. 298.

Tension test.

Mark on bar, $\overset{\text{W;T.}}{\text{I.}}$
Length, 2″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000200	.000200	0.	....	
2, 500	10, 000	.000400	.000200	.000050	.000050	
3, 750	15, 000	.000700	.000300	.000100	.000050	
5, 000	20, 000	.000750	.000050	.000150	.000050	
6, 250	25, 000	.001000	.000250	.000150	0.	
7, 500	30, 000	.001150	.000150	.000150	0.	
8, 750	35, 000	.001200	.000050	.000150	0.	
10, 000	40, 000	.001400	.000200	.000150	0.	
10, 250	41, 000	.001500	.000100	....	....	
10, 500	42, 000	.001500	0.	....	....	
10, 750	43, 000	.001550	.000050	....	....	
11, 000	44, 000	.001550	0.	....	....	
11, 250	45, 000	.001600	.000050	.000150	0.	
11, 500	46, 000	.001600	0.	....	....	
11, 750	47, 000	.001650	.000950	....	....	
12, 000	48, 000	.001700	.000050	....	....	
12, 250	49, 000	.001750	.000050	....	....	
12, 500	50, 000	.001800	.000050	.000250	.000100	
12, 750	51, 000	.001900	.000100	....	....	
13, 000	52, 000	.001950	.000050	....	....	
13, 250	53, 000	.002000	.000050	....	....	Elastic limit.
13, 500	54, 000	.002100	.000100	....	....	
13, 750	55, 000	.002200	.000100	.000450	.000200	
14, 000	56, 000	.002350	.000150	....	....	
14, 250	57, 000	.002400	.000050	....	....	
14, 500	58, 000	.002550	.000150	....	....	
14, 750	59, 000	.002700	.000150	....	....	
15, 000	60, 000	.002950	.000250	.001100	.000650	
15, 250	61, 000	.003200	.000250	....	....	
15, 500	62, 000	.003600	.000400	....	....	
15, 750	63, 000	.004000	.000400	....	....	
16, 000	64, 000	.004750	.000750	....	....	
16, 250	65, 000	.005200	.000450	.002950	.001850	
16, 500	66, 000	.006000	.000800	....	....	
16, 750	67, 000	.006600	.000600	....	....	
17, 000	68, 000	.007500	.000900	....	....	
17, 250	69, 000	.008350	.000850	....	....	
17, 500	70, 000	.009500	.001150	.006850	.003900	
18, 000	72, 000	.010950	.001450	....	....	
18, 500	74, 000	.013500	.002550	....	....	
19, 000	76, 000	.015250	.001750	....	....	
19, 500	78, 000	.017150	.001900	....	....	
20, 000	80, 000	.019400	.002250	....	....	
20, 500	82, 000	.021850	.002450	....	....	
21, 000	84, 000	.024400	.002550	....	....	
21, 500	86, 000	.027150	.002750	....	....	
22, 000	88, 000	.030000	.002850	....	....	
22, 500	90, 000	.033550	.003550	....	....	Micrometer removed.
23, 000	92, 000	.0350	.001450	....	....	
23, 500	94, 000	.0375	.0025	....	....	
24, 000	96, 000	.0450	.0075	....	....	
24, 500	98, 000	.0550	.0100	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
25, 000	100, 000	.0650	.0100	....	....	
25, 500	102, 000	.0775	.0125	....	....	
25, 980	103, 920	.1200	.0425	....	....	Ultimate strength.
23, 900	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section........pounds.. 103, 920
Elastic limit per square inch of original section........do... 53, 000
Elongation per inch after rupture........inch.. 0. 1525
Elongation per inch under strain at elastic limit........do... .0020
Reduction in diameter at point of rupture........ .094
Reduction in area after rupture, per centum of original section........ 30. 8
Position of rupture........ ½ inch from neck.
Character of broken surface........ fine granular, silvery luster, with small dull spot at center.

No. 299.

Tension test.

Mark on bar, $^{\mathrm{W.\ T.}}_{\mathrm{2.}}$
Length, 2″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	Initial load.
1, 250	5, 000	.000100	.000100	0.	....	
2, 500	10, 000	.000350	.000250	0.	....	
3, 750	15, 000	.000600	.000250	0.	....	
5, 000	20, 000	.000700	.000100	0.	....	
6, 250	25, 000	.000900	.000200	0.	....	
7, 500	30, 000	.001050	.000150	.000050	.000050	
8, 750	35, 000	.001250	.000200	.000050	0.	
10, 000	40, 000	.001500	.000250	.000150	.000100	
10, 250	41, 000	.001550	.000050	....	....	
10, 500	42, 000	.001600	.000050	....	....	
10, 750	43, 000	.001650	.000050	....	....	
11, 000	44, 000	.001700	.000050	....	....	
11, 250	45, 000	.001750	.000050	.000300	.000150	
11, 500	46, 000	.001800	.000050	....	....	
11, 750	47, 000	.001850	.000050	....	....	
12, 000	48, 000	.001900	.000050	....	....	
12, 250	49, 000	.001950	.000050	....	....	
12, 500	50, 000	.002000	.000050	.000350	.000050	
12, 750	51, 000	.002150	.000150	....	....	
13, 000	52, 000	.002250	.000100	....	....	
13, 250	53, 000	.002300	.000050	....	....	
13, 500	54, 000	.002400	.000100	....	....	Elastic limit.
13, 750	55, 000	.002500	.000100	.000750	.000400	
14, 000	56, 000	.002700	.000200	....	....	
14, 250	57, 000	.002800	.000100	....	....	
14, 500	58, 000	.002900	.000100	....	....	
14, 750	59, 000	.003050	.000150	....	....	
15, 000	60, 000	.003200	.000150	.001300	.000550	
15, 250	61, 000	.003550	.000350	....	....	
15, 500	62, 000	.004050	.000500	....	....	
15, 750	63, 000	.004250	.000200	....	....	
16, 000	64, 000	.005050	.000800	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16,250	65,000	.005700	.000650	.003350	.002050	
16,500	66,000	.006250	.000550	....	....	
16,750	67,000	.006900	.000650	....	....	
17,000	68,000	.007950	.001050	....	....	
17,250	69,000	.008600	.000650	....	....	
17,500	70,000	.009800	.001200	.007250	.003900	
18,000	72,000	.011300	.001500	....	....	
18,500	74,000	.013400	.002100	....	....	
19,000	76,000	.015500	.002100	....	....	
19,500	78,000	.017650	.002150	....	....	
20,000	80,000	.020050	.002400	....	....	Rested under initial load one hour.
20,500	82,000	.022050	.002000	....	....	
21,000	84,000	.024800	.002750	....	....	
21,500	86,000	.028000	.003200	....	....	
22,000	88,000	.031000	.003000	....	....	
22,500	90,000	.034800	.003800	....	....	Micrometer removed.
23,000	92,000	.0400	.0052	....	....	
23,500	94,000	.0450	.0050	....	....	
24,000	96,000	.0500	.0050	....	....	
24,500	98,000	.0575	.0075	....	....	
25,000	100,000	.0700	.0125	....	....	
25,500	102,000	.0850	.0150	....	....	
25,690	102,760	.1200	.0350	....	....	Ultimate strength.
23,800	....	....	....	....	....	Load at time of rupture.

General summary.

Specific gravity	7.8687
Hardness	24.12
Tensile strength per square inch of original section ....pounds..	102,760
Elastic limit per square inch of original section ....do...	54,000
Elongation per inch after rupture ....inch..	0.1675
Elongation per inch under strain at elastic limit ....do ..	.0024
Reduction in diameter at point of rupture ....do...	.104
Reduction in area after rupture, per centum of original section	33.6
Position of rupture	½ inch from neck.
Character of broken surface	fine granular, silvery luster; dull spot at circumference of the ruptured surface.

No. 300.

Tension test.

Mark on bar, $^{\text{W. T.}}_{3}$.
Length, 2″.
Diameter, ″.564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	0.	0.	0.	Initial load.
1,250	5,000	.000100	.000100	0.	....	
2,500	10,000	.000200	.000100	0.	....	
3,750	15,000	.000450	.000250	0.	....	
5,000	20,000	.000550	.000100	0.	....	
6,250	25,000	.000600	.000050	0.	....	
7,500	30,000	.000800	.000200	0.	....	
8,750	35,000	.001000	.000200	0.	....	
10,000	40,000	.001200	.000200	0.	....	
10,250	41,000	.001250	.000050	....	....	
10,500	42,000	.001300	.000050	....	....	
10,750	43,000	.001300	0.	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
11,000	44,000	.001350	.000050			
11,250	45,000	.001350	0.	0.		
11,500	46,000	.001400	.000050			
11,750	47,000	.001400	0.			
12,000	48,000	.001450	.000050			
12,250	49,000	.001450	0.			
12,500	50,000	.001500	.000050	.000050	.000050	
12,750	51,000	.001600	.000100			
13,000	52,000	.001650	.000050			
13,250	53,000	.001700	.000050			
13,500	54,000	.001750	.000050			
13,750	55,000	.001800	.000050	.000300	.000250	Elastic limit.
14,000	56,000	.002000	.000200			
14,250	57,000	.002200	.000200			
14,500	58,000	.002250	.000050			
14,750	59,000	.002350	.000100			
15,000	60,000	.002500	.000150	.000700	.000400	
15,250	61,000	.002550	.000050			
15,500	62,000	.002750	.000200			
15,750	63,000	.003100	.000350			
16,000	64,000	.003450	.000350			
16,250	65,000	.003900	.000350	.001800	.001100	
16,500	66,000	.004400	.000500			
16,750	67,000	.005050	.000650			
17,000	68,000	.005900	.000850			
17,250	69,000	.006350	.000450			
17,500	70,000	.006950	.000600	.005100	.003300	
18,000	72,000	.008550	.001600			
18,500	74,000	.010850	.002300			
19,000	76,000	.013000	.002150			
19,500	78,000	.014350	.001350			
20,000	80,000	.016500	.002150			
20,500	82,000	.018500	.002000			
21,000	84,000	.020850	.002350			
21,500	86,000	.023200	.002350			
22,000	88,000	.025800	.002600			
22,500	90,000	.028750	.002950			
23,000	92,000	.030950	.002200			
23,500	94,000	.034000	.003050			
24,000	96,000	.038250	.003350			
24,500	98,000	.0425	.004250			Micrometer removed.
25,000	100,000	.0500	.0075			
25,500	102,000	.0600	.0100			
26,000	104,000	.0650	.0050			
26,500	106,000	.0875	.0225			
26,640	106,560	.1225	.0350			Ultimate strength.
24,900						Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds	106,560
Elastic limit per square inch of original section	do	55,000
Elongation per inch after rupture	inch	0.1550
Elongation per inch under strain at elastic limit	do	.0018
Reduction in diameter at point of rupture	do	.084
Reduction in area after rupture, per centum of original section		27.6
Position of rupture		¾ inch from neck.
Character of broken surface		fine granular, silvery luster; dull spots near the center.

No. 301.

Tension test.

Mark on bar, $^{W.}{}_{4}{}^{T.}$
Length, 2″.
Diameter, .″564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	0.	0.	0.	Initial load.
1,250	5,000	.000050	.000050	0.	....	
2,500	10,000	.000200	.000150	0.	....	
3,750	15,000	.000300	.000100	0.	....	
5,000	20,000	.000500	.000200	0.	....	
6,250	25,000	.000600	.000100	0.	....	
7,500	30,000	.000800	.000200	0.	....	
8,750	35,000	.001000	.000200	0.	....	
10,000	40,000	.001100	.000100	0.	....	
10,250	41,000	.001100	0.	....	....	
10,500	42,000	.001150	.000050	....	....	
10,750	43,000	.001150	0.	....	....	
11,000	44,000	.001200	.000050	....	....	
11,250	45,000	.001250	.000050	.000100	.000100	
11,500	46,000	.001300	.000050	....	....	
11,750	47,000	.001350	.000050	....	....	
12,000	48,000	.001400	.000050	....	....	
12,250	49,000	.001450	.000050	....	....	
12,500	50,000	.001500	.000050	.000100	0.	
12,750	51,000	.001600	.000100	....	....	
13,000	52,000	.001650	.000050	....	....	
13,250	53,000	.001700	.000050	....	....	
13,500	54,000	.001750	.000050	....	....	
13,750	55,000	.001800	.000050	.000300	.000200	Elastic limit.
14,000	56,000	.002100	.000300	....	....	
14,250	57,000	.002250	.000150	....	....	
14,500	58,000	.002350	.000100	....	....	
14,750	59,000	.002500	.000150	....	....	
15,000	60,000	.003100	.000600	.001300	.001000	
15,250	61,000	.003500	.000400	....	....	
15,500	62,000	.004000	.000500	....	....	
15,750	63,000	.004550	.000550	....	....	
16,000	64,000	.005450	.000900	....	....	
16,250	65,000	.005950	.000500	.003850	.002550	
16,500	66,000	.006950	.001000	....	....	
16,750	67,000	.007550	.000600	....	....	
17,000	68,000	.008600	.001050	....	....	
17,250	69,000	.009350	.000750	....	....	
17,500	70,000	.010450	.001100	.007830	.004000	
18,000	72,000	.012150	.001700	....	....	
18,500	74,000	.014000	.001850	....	....	
19,000	76,000	.016250	.002250	....	....	
19,500	78,000	.018250	.002000	....	....	
20,000	80,000	.020600	.002350	....	....	
20,500	82,000	.022600	.002000	....	....	
21,000	84,000	.025600	.003000	....	....	
21,500	86,000	.028150	.002550	....	....	
22,000	88,000	.030700	.002550	....	....	
22,500	90,000	.034600	.003900	....	....	
23,000	92,000	.038300	.003700	....	....	
23,500	94,000	.043200	.004900	....	....	
24,000	96,000	.048200	.005000	....	....	Micrometer removed.
24,500	98,000	.0525	.0043	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
25, 000	100, 000	. 0675	. 0150	....	....	
25, 500	102, 000	. 0750	. 0075	....	....	
25, 960	103, 840	. 0800	. 0050	....	....	Ultimate strength.
23, 000	....	....	....	....	....	Load at time of rupture.

General summary.

Specific gravity		7. 8666
Hardness		25. 73
Tensile strength per square inch of original section	pounds..	103, 840
Elastic limit per square inch of original section	do...	55, 000
Elongation per inch after rupture	inch..	0. 1650
Elongation per inch under strain at elastic limit	do...	. 0018
Reduction in diameter at point of rupture	do ..	. 094
Reduction in area after rupture, per centum of original section		30. 8
Position of rupture		''70 from neck.
Character of broken surface		fine granular, silvery luster; dull center.

No. 302.

Tension test.

Mark on bar, $^{\mathrm{W.\,T.}}_{5}$
Length, 2''.
Diameter, .''564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	0.	0.	0.	
1, 250	5, 000	. 000050	. 000050	0.	....	Initial load.
2, 500	10, 000	. 000250	. 000200	0.	....	
3, 750	15, 000	. 000400	. 000150	0.	....	
5, 000	20, 000	. 000600	. 000200	0.	....	
6, 250	25, 000	. 000700	. 000100	0.	....	
7, 500	30, 000	. 000900	. 000200	0.	....	
8, 750	35, 000	. 001050	. 000150	0.	....	
10, 000	40. 000	. 001250	. 000200	0.	....	
10, 250	41, 000	. 001250	0.	....	....	
10, 500	42, 000	. 001300	. 000050	....	....	
10, 750	43, 000	. 001300	0.	....	....	
11, 000	44, 000	. 001350	. 000050	....	....	
11, 250	45, 000	. 001400	. 000050	. 000050	. 000050	
11, 500	46, 000	. 001400	0.	....	....	
11, 750	47, 000	. 001450	. 000050	....	....	
12, 000	48, 000	. 001500	. 000050	....	....	
12, 250	49, 000	. 001550	. 000050	....	....	
12, 500	50, 000	. 001600	. 000050	. 000150	. 000100	
12, 750	51, 000	. 001750	. 000150	....	....	
13, 000	52, 000	. 001850	. 000100	....	....	
13, 250	53, 000	. 001950	. 000100	....	....	
13, 500	54, 000	. 002200	. 000250	....	....	Elastic limit.
13, 750	55, 000	. 002350	. 000150	. 000650	. 000500	
14, 000	56, 000	. 002700	. 000350	....	....	
14, 250	57, 000	. 003200	. 000500	....	....	
14, 500	58, 000	. 003700	. 000500	....	....	
14, 750	59, 000	. 004250	. 000550	....	....	
15, 000	60, 000	. 005000	. 000750	. 003000	. 002350	
15, 250	61, 000	. 005700	. 000700	....	....	
15, 500	62, 000	. 006500	. 000800	....	....	
15, 750	63, 000	. 007100	. 000600	....	....	
16, 000	64, 000	. 008450	. 001350	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
16,250	65,000	.009000	.000550	.006550	.003550	
16,500	66,000	.009650	.000650	....	....	
16,750	67,000	.010250	.000600	....	....	
17,000	68,000	.011650	.001400	....	....	
17,250	69,000	.012250	.001400	....	....	
17,500	70,000	.013550	.001300	.010850	.004300	
18,000	72,000	.015100	.001550	....	....	
18,500	74,000	.017450	.002350	....	....	
19,000	76,000	.019800	.002350	....	....	
19,500	78,000	.022050	.002250	....	....	
20,000	80,000	.024600	.002550	....	....	
20,500	82,000	.027650	.003050	....	....	
21,000	84,000	.030550	.002900	....	....	
21,500	86,000	.033600	.003050	....	....	
22,000	88,000	.037100	.003500	....	....	
22,500	90,000	.043250	.006150	....	....	
23,000	92,000	.047550	.004300	....	....	
23,500	94,000	.053550	.006000	....	....	Micrometer removed.
24,000	96,000	.0600	.006450	....	....	
24,500	98,000	.0750	.0150	....	....	
25,000	100,000	.1000	.0250	....	....	
25,070	100,280	.1350	.0350	....	....	Ultimate strength.
22,900	....	....	....	....	....	Load at time of rupture.

General summary.

Tensile strength per square inch of original section	pounds..	100,280
Elastic limit per square inch of original section	do....	53,000
Elongation per inch after rupture	inch..	0.16750
Elongation per inch under strain at elastic limit	do...	.00195
Reduction in diameter at point of rupture	do...	.104
Reduction in area after rupture, per centum of original section		33.6
Position of rupture		".70 from neck.
Character of broken surface		fine granular, silvery luster; dull center.

No. 303.

Tension test.

Mark on bar, $^{\text{W. T.}}_{\;\;6}$.
Length, 2".
Diameter, ".564.
Sectional area, .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1,000	0.	0.	0.	0.	Initial load.
1,250	5,000	.000100	.000100	0.	....	
2,500	10,000	.000250	.000150	0.	....	
3,750	15,000	.000400	.000150	0.	....	
5,000	20,000	.000650	.000250	0.	....	
6,250	25,000	.000800	.000150	0.	....	
7,500	30,000	.001000	.000200	0.	....	
8,750	35,000	.001100	.000100	.000050	.000050	
10,000	40,000	.001300	.000200	.000050	0.	
10,250	41,000	.001300	0.	....	....	
10,500	42,000	.001350	.000050	....	....	
10,750	43,000	.001400	.000050	....	....	
11,000	44,000	.001450	.000050	....	....	
11,250	45,000	.001500	.000050	.000050	0.	
11,500	46,000	.001550	.000050	....	....	
11,750	47,000	.001600	.000050	....	....	

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
12, 000	48, 000	.001650	.000050			
12, 250	49, 000	.001700	.000050			
12, 500	50, 000	.001750	.000050	.000200	.000150	
12, 750	51, 000	.001800	.000050			
13, 000	52, 000	.001850	.000050			
13, 250	53, 000	.001900	.000050			Elastic limit.
13, 500	54, 000	.002050	.000150			
13, 750	55, 000	.002350	.000300	.000600	.000400	
14, 000	56, 000	.002650	.000300			
14, 250	57, 000	.002950	.000300			
14, 500	58, 000	.003450	.000500			
14, 750	59, 000	.003950	.000500			
15, 000	60, 000	.004550	.000600	.002600	.002600	
15, 250	61, 000	.005400	.000850			
15, 500	62, 000	.005950	.000550			
15, 750	63, 000	.006650	.000700			
16, 000	64, 000	.007700	.001050			
16, 250	65, 000	.008350	.000650	.006000	.003400	
16, 500	66, 000	.009300	.000950			
16, 750	67, 000	.009900	.000600			
17, 000	68, 000	.011050	.001150			
17, 250	69, 000	.011750	.000700			
17, 500	70, 000	.012900	.001150	.010250	.004250	
18, 000	72, 000	.014800	.001900			
18, 500	74, 000	.016900	.002100			
19, 000	76, 000	.019000	.002100			
19, 500	78, 000	.021450	.002450			
20, 000	80, 000	.023700	.002250			
20, 500	82, 000	.026450	.002750			
21, 000	84, 000	.029550	.003100			
21, 500	86, 000	.032750	.003200			
22, 000	88, 000	.036450	.003700			
22, 500	90, 000	.039950	.003500			
23, 000	92, 000	.045450	.005500			
23, 500	94, 000	.051450	.006000			Micrometer removed.
24, 000	96, 600	.0600	.008550			
24, 500	98, 000	.0700	.0100			
25, 000	100, 000	.0900	.0200			
25, 110	100, 440	.1150				Ultimate strength.
23, 300						Load at time of rupture.

General summary.

Tensile strength per square inch of original section ....pounds.. 100, 440
Elastic limit per square inch of original section ....do... 53, 000
Elongation per inch after rupture ....inch.. 0. 1625
Elongation per inch under strain at elastic limit ....do... .0019
Reduction in diameter at point of rupture ....do... .104
Reduction in area after rupture, per centum of original section 33. 6
Position of rupture .... ½ inch from neck.
Character of broken surface ....fine granular, silvery luster, dull center.

CAST IRON FROM BREECH DISK OF 10″ WIRE-WOUND GUN.

[From South Boston Iron Works.]

No. 308.

Tension test.

Mark on bar, 4.
Length, 20″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1,000	1,000	.000015	.000015	0.	....	
2,000	2,000	.000060	.000045	0.	....	
3,000	3,000	.000110	.000050	0.	....	
4,000	4,000	.000160	.000050	0.	....	
5,000	5,000	.000220	.000060	.000005	.000005	
6,000	6,000	.000260	.000040	.000010	.000005	
7,000	7,000	.000310	.000050	.000010	0.	
8,000	8,000	.000360	.000050	.000010	0.	
9,000	9,000	.000425	.000065	.000025	.000015	
10,000	10,000	.000490	.000065	.000040	.000015	
11,000	11,000	.000545	.000055	.000045	.000005	
12,000	12,000	.000610	.000065	.000045	0.	
13,000	13,000	.000650	.000040	.000055	.000010	
14,000	14,000	.000720	.000070	.000060	.000005	
15,000	15,000	.000795	.000075	.000065	.000005	Elastic limit.
16,000	16,000	.000870	.000075	.000090	.000025	
17,000	17,000	.000945	.000075	.000100	.000010	
18,000	18,000	.001035	.000090	.000135	.000035	
19,000	19,000	.001125	.000090	.000150	.000015	
20,000	20,000	.001225	.000100	.000190	.000040	
21,000	21,000	.001320	.000095	.000220	.000030	
22,000	22,000	.001445	.000125	.000270	.000050	
23,000	23,000	.001555	.000110	.000320	.000050	
24,000	24,000	.001710	.000155	.000390	.000070	
25,000	25,000	.001880	.000170	.000490	.000100	
26,000	26,000	.002015	.000135	.000550	.000060	
27,000	27,000	.002250	.000235	.000695	.000145	
28,000	28,000	.002540	.000290	.000900	.000205	
29,000	29,000	.002900	.000360	.001185	.000285	
29,120	29,120	....	....	....	....	Ultimate strength.

General summary.

Tensile strength per square inch of original section	pounds..	29,120
Elastic limit per square inch of original section	do ...	15,000
Elongation per inch under strain at elastic limit	inch..	0.000795
Position of rupture		2″ from middle.
Character of broken surface		coarse granular.

No. 309.

Tension test.

Mark on bar, 5.
Length, 20''.
Diameter, 1''.129.
Sectional area, 1 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1, 000	1, 000	.000015	.000015	0.	....	
2, 000	2, 000	.000065	.000050	0.	....	
3, 000	3, 000	.000115	.000050	0.	....	
4, 000	4, 000	.000160	.000045	0.	....	
5, 000	5, 000	.000205	.000045	0.	....	
6, 000	6, 000	.000255	.000050	0.	....	
7, 000	7, 000	.000305	.000050	0.	....	
8, 000	8, 000	.000350	.000045	0.	....	
9, 000	9, 000	.000400	.000050	.000005	.000005	
10, 000	10, 000	.000470	.000070	.000010	.000005	
11, 000	11, 000	.000520	.000050	.000020	.000010	
12, 000	12, 000	.000595	.000075	.000040	.000020	
13, 000	13, 000	.000650	.000055	.000045	.000005	
14, 000	14, 000	.000730	.000080	.000050	.000005	
15, 000	15, 000	.000795	.000065	.000060	.000010	Elastic limit.
16, 000	16, 000	.000870	.000075	.000080	.000020	
17, 000	17, 000	.000950	.000080	.000100	.000020	
18, 000	18, 000	.001035	.000085	.000130	.000030	
19, 000	19, 000	.001130	.000095	.000140	.000010	
20, 000	20, 000	.001235	.000005	.000185	.000045	
21, 000	21, 000	.001335	.000100	.000215	.000030	
22, 000	22, 000	.001450	.000115	.000265	.000050	
23, 000	28, 000	.001575	.000125	.000325	.000060	
24, 000	24, 000	.001730	.000155	.000405	.000080	
24, 950	24, 950	....	....	....	....	Ultimate strength.

General summary.

Specific gravity	7. 2769
Hardness	15. 74
Tensile strength per square inch of original section......pounds..	24, 950
Elastic limit per square inch of original section......do....	15, 000
Elongation per inch under strain at elastic limit......inch..	0. 000795
Position of rupture	1 inch from neck.
Character of broken surface	coarse granular.

No. 363.

Compression test.

Mark on bar, 6.
Length, 12″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1,000	1,000	.000030	.000030	0.	....	
2,000	2,000	.000090	.000060	0.	....	
3,000	3,000	.000130	.000040	0.	....	
4,000	4,000	.000190	.000060	0.	....	
5,000	5,000	.000230	.000040	0.	....	
6,000	6,000	.000270	.000040	0.	....	
7,000	7,000	.000330	.000060	.000020	.000020	
8,000	8,000	.000390	.000060	.000080	.000010	
9,000	9,000	.000430	.000040	.000040	.000010	
10,000	10,000	.000480	.000050	.000040	0.	
11,000	11,000	.000540	.000060	.000050	.000010	
12,000	12,000	.000590	.000050	.000060	.000010	
13,000	13,000	.000640	.000050	.000070	.000010	
14,000	14,000	.000700	.000060	.000080	.000010	
15,000	15,000	.000760	.000060	.000100	.000020	
16,000	16,000	.000820	.000060	.000100	0.	
17,000	17,000	.000860	.000040	.000100	0.	
18,000	18,000	.000940	.000080	.000100	0.	
19,000	19,000	.000990	.000050	.000110	.000010	
20,000	20,000	.001060	.000070	.000130	.000020	
21,000	21,000	.001130	.000070	.000140	.000010	
22,000	22,000	.001200	.000070	.000170	.000030	
23,000	23,000	.001260	.000060	.000180	.000010	
24,000	24,000	.001320	000060	.000190	.000010	
25,000	25,000	.001430	.000110	.000230	.000040	
26,000	26,000	.001490	.000060	.000240	.000010	
27,000	27,000	.001580	.000090	.000280	.000040	
28,000	28,000	.001680	.000100	.000300	.000020	
29,000	29,000	.001740	.000060	.000330	.000030	Perceptible deflection.
30,000	30,000	.001860	.000120	.000430	.000100	
31,000	31,000	.001990	.000130	.000480	.000050	
32,000	32,000	.002130	.000140	.000550	.000070	
33,000	33,000	.002280	.000150	.000640	.000090	
34,000	34,000	.002460	.000180	.000780	.000140	
35,000	35,000	.002630	.000170	.000880	.000100	
36,000	36,000	.002890	.000260	.001100	.000120	
37,000	37,000	.003150	.000260	.001320	.000220	
38,000	38,000	.003450	.000300	.001550	.000230	
39,000	39,000	.003790	.000340	.001880	.000330	
40,000	40,000	.004100	.000310	.002100	.000220	Micrometer removed.
52,850	52,850	....	....	....	....	Ultimate strength.

Failed by triple flexure.

Fracture started at the middle on the tension side when the deflection reached ″.42.

No. 362.

Compression test.

Marks on bar, 7.
Length, 12″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent Set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1, 000	1, 000	.000030	.000030	0.	....	
2, 000	2, 000	.000090	.000060	0.	....	
3, 000	3, 000	.000130	.000040	0.	....	
4, 000	4, 000	.000190	.000060	0.	....	
5, 000	5, 000	.000230	.000040	0.	....	
6, 000	6, 000	.000290	.000060	0.	....	
7, 000	7, 000	.000330	.000040	0.	....	
8, 000	8, 000	.000390	.000060	.000030	.000030	
9, 000	9, 000	.000430	.000040	.000030	0.	
10, 000	10, 000	.000500	.000070	.000040	.000010	
11, 000	11, 000	.000550	.000050	.000050	.000010	
12, 000	12, 000	.000600	.000050	.000070	.000020	
13, 000	13, 000	.000680	.000080	.000080	.000010	
14, 000	14, 000	.000710	.000030	.000090	.000010	
15, 000	15, 000	.000770	.000060	.000100	.000010	
16, 000	16, 000	.000840	.000070	.000100	0.	
17, 000	17, 000	.000900	.000060	.000100	0.	
18, 000	18, 000	.000980	.000080	.000110	.000010	
19, 000	19, 000	.001040	.000060	.000120	.000010	
20, 000	20, 000	.001100	.000060	.000130	.000010	
21, 000	21, 000	.001180	.000080	.000150	.000020	
22, 000	22, 000	.001240	.000060	.000180	.000030	
23, 000	23, 000	.001320	.000080	.000190	.000010	
24, 000	24, 000	.001390	.000070	.000200	.000010	
25, 000	25, 000	.001480	.000090	.000240	.000040	Perceptible deflection.
26, 000	26, 000	.001570	.000090	.000290	.000050	
27, 000	27, 000	.001650	.000080	.000310	.000020	
28, 000	28, 000	.001750	.000100	.000380	.000070	
29, 000	29, 000	.001860	.000110	.000410	.000030	
30, 000	30, 000	.001970	.000110	.000490	.000080	
31, 000	31, 000	.002110	.000140	.000580	.000090	
32, 000	32, 000	.002290	.000180	.000680	.000100	
33, 000	33, 000	.002440	.000150	.000790	.000110	
34, 000	34, 000	.002640	.000200	.000930	.000140	
35, 000	35, 000	.002930	.000290	.001150	.000220	
36, 000	36, 000	.003130	.000200	.001330	.000180	
37, 000	37, 000	.003460	.000330	.001600	.000270	
38, 000	38, 000	.003780	.000320	.001860	.000260	
39, 000	39, 000	.004150	.000370	.002180	.000320	
40, 000	40, 000	.004540	.000390	.002530	.000350	Micrometer removed.
52, 140	52, 140	....	....	....	....	Ultimate strength.

Failed by triple flexure.

No. 364.

Compression test.

Mark on bar, 8.
Length, 12″.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1, 000	1, 000	.000030	.000030	0.	....	
2, 000	2, 000	.000090	.000060	0.	....	
3, 000	3, 000	.000130	.000040	0.	....	
4, 000	4, 000	.000170	.000040	0.	....	
5, 000	5, 000	.000230	.000060	0.	....	
6, 000	6, 000	.000270	.000040	0.	....	
7, 000	7, 000	.000320	.000050	0.	....	
8, 000	8, 000	.000360	.000040	0.	....	
9, 000	9, 000	.000410	.000050	0.	....	
10, 000	10, 000	.000470	.000060	.000030	.000030	
11, 000	11, 000	.000510	.000040	.000040	.000010	
12, 000	12, 000	.000570	.000060	.000050	.000010	
13, 000	13, 000	.000630	.000060	.000060	.000010	
14, 000	14, 000	.000670	.000040	.000060	0.	
15, 000	15, 000	.000720	.000050	.000070	.000010	
16, 000	16, 000	.000770	.000050	.000080	.000010	
17, 000	17, 000	.000830	.000060	.000090	.000010	
18, 000	18, 000	.000870	.000040	.000090	0.	
19, 000	19, 000	.000970	.000100	.000100	.000010	
20, 000	20, 000	.001030	.000060	.000110	.000010	
21, 000	21, 000	.001070	.000040	.000110	0.	
22, 000	22, 000	.001150	.000080	.000130	.000020	
23, 000	23, 000	.001200	.000050	.000140	.000010	
24, 000	24, 000	.001270	.000070	.000160	.000020	
25, 000	25, 000	.001330	.000060	.000170	.000010	
26, 000	26, 000	.001430	.000100	.000190	.000020	
27, 000	27, 000	.001470	.000040	.000200	.000010	
28, 000	28, 000	.001550	.000080	.000230	.000030	
29, 000	29, 000	.001630	.000080	.000250	.000020	
30, 000	30, 000	.001730	.000100	.000270	.000020	
31, 000	31, 000	.001770	.000040	.000310	.000040	Perceptible deflection.
32, 000	32, 000	.001870	.000100	.000360	.000050	
33, 000	33, 000	.001970	.000100	.000400	.000040	
34, 000	34, 000	.002130	.000160	.000460	.000060	
35, 000	35, 000	.002230	.000100	.000520	.000060	
36, 000	36, 000	.002360	.000130	.000600	.000080	
37, 000	37, 000	.002470	.000110	.000690	.000090	
38, 000	38, 000	.002630	.000160	.000770	.000080	
39, 000	39, 000	.002830	.000200	.000950	.000180	
40, 000	40, 000	.003030	.000200	.001100	.000150	
55, 669	55, 690	....	....	....	....	Ultimate strength.

Failed by triple flexure.
Fractures started on tension side when middle deflection reached ″.43.

No. 365.

Compression test.

Mark on bar, 10.
Length, 11''.66.
Diameter, 1''.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1,000	1,000	.000018	.000018	0.	....	
2,000	2,000	.000036	.000018	0.	....	
3,000	3,000	.000072	.000036	0.	....	
4,000	4,000	.000109	.000037	0.	....	
5,000	5,000	.000164	.000055	0.	....	
6,000	6,000	.000217	.000053	0.	....	
7,000	7,000	.000273	.000056	0.	....	
8,000	8,000	.000309	.000036	0.	....	
9,000	9,000	.000345	.000036	0.	....	
10,000	10,000	.000381	.000036	.000018	.000018	
11,000	11,000	.000453	.000072	.000018	0.	
12,000	12,000	.000489	.000036	.000036	.000018	
13,000	13,000	.000525	.000036	.000036	0.	
14,000	14,000	.000561	.000036	.000036	0.	
15,000	15,000	.000670	.000109	.000054	.000019	
16,000	16,000	.000688	.000018	.000054	0.	
17,000	17,000	.000746	.000058	.000072	.000018	
18,000	18,000	.000800	.000054	.000091	.000019	
19,000	19,000	.000855	.000055	.000109	.000018	
20,000	20,000	.000891	.000036	.000127	.000018	
21,000	21,000	.000963	.000072	.000127	0.	
22,000	22,000	.001035	.000072	.000127	0.	
23,000	23,000	.001071	.000036	.000127	0.	
24,000	24,000	.001148	.000072	.000145	.000018	
25,000	25,000	.001215	.000072	.000145	0.	
26,000	26,000	.001287	.000072	.000163	.000018	
27,000	27,000	.001359	.000072	.000181	.000018	
28,000	28,000	.001431	.000072	.000217	.000036	
29,000	29,000	.001467	.000036	.000235	.000018	
30,000	30,000	.001594	.000127	.000253	.000018	Perceptible deflection.
31,000	31,000	.001727	.000133	.000307	.000054	
32,000	32,000	.001799	.000072	.000343	.000036	
33,000	33,000	.001891	.000092	.000415	.000072	
34,000	34,000	.001981	.000090	.000469	.000054	
35,000	35,000	.002127	.000146	.000541	.000072	
36,000	36,000	.002345	.000218	.000670	.000129	
37,000	37,000	.002490	.000145	.000779	.000109	
38,000	38,000	.002672	.000182	.000906	.000127	
39,000	39,000	.003000	.000328	.001143	.000237	
40,000	40,000	.003290	.000290	.001359	.000216	Micrometer removed.
61,900	61,900	....	....	....	....	Ultimate strength.

Failed by triple flexure.

Cracks developed on the tension side, when the middle deflection reached ''.38.

No. 366.

Compression test.

Mark on bar, 11.
Length, 11″.66.
Diameter, 1″.129.
Sectional area, 1 square inch.

Applied loads.		Compression per inch.	Successive compression per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	500	0.	0.	0.	0.	Initial load.
1,000	1,000	.000018	.000018	0.	....	
2,000	2,000	.000036	.000018	0.	....	
3,000	3,000	.000072	.000036	0.	....	
4,000	4,000	.000109	.000037	0.	....	
5,000	5,000	.000145	.000036	.000018	.000018	
6,000	6,000	.000217	.000072	.000018	0.	
7,000	7,000	.000253	.000036	.000018	0.	
8,000	8,000	.000289	.000036	.000018	0.	
9,000	9,000	.000325	.000036	.000018	0.	
10,000	10,000	.000361	.000036	.000018	0.	
11,000	11,000	.000415	.000054	.000036	.000018	
12,000	12,000	.000453	.000038	.000036	0.	
13,000	13,000	.000525	.000072	.000036	0.	
14,000	14,000	.000561	.000036	.000036	0.	
15,000	15,000	.000597	.000036	.000036	0.	
16,000	16,000	.000651	.000054	.000054	.000018	
17,000	17,000	.000705	.000054	.000054	0.	
18,000	18,000	.000759	.000054	.000054	0.	
19,000	19,000	.000831	.000072	.000072	.000018	
20,000	20,000	.000935	.000104	.000072	0.	
21,000	21,000	.000971	.000036	.000072	0.	
22,000	22,000	.001025	.000054	.000072	0.	
23,000	23,000	.001071	.000046	.000091	.000019	
24,000	24,000	.001107	.000036	.000109	.000018	
25,000	25,000	.001161	.000054	.000127	.000018	
26,000	26,000	.001233	.000072	.000163	.000036	
27,000	27,000	.001305	.000072	.000181	.000018	
28,000	28,000	.001359	.000054	.000199	.000018	
29,000	29,000	.001454	.000095	.000217	.000018	
30,000	30,000	.001526	.000072	.000273	.000056	Perceptible deflection.
31,000	31,000	.001635	.000109	.000289	.000016	
32,000	32,000	.001727	.000092	.000325	.000036	
33,000	33,000	.001854	.000127	.000381	.000056	
34,000	34,000	.001963	.000109	.000435	.000054	
35,000	35,000	.002091	.000128	.000507	.000072	
36,000	36,000	.002236	.000145	.000579	.000072	
37,000	37,000	.002454	.000218	.000746	.000167	
38,000	38,000	.002618	.000164	.000831	.000085	
39,000	39,000	.003054	.000436	.001012	.000181	
40,000	40,000	.003127	.000073	.001193	.000181	Micrometer removed.
60,710	60,710	....	....	....	....	Ultimate strength.

Failed by triple flexure.

Fracture developed on the tension side when the middle deflection reached ″.38.

BRONZE SPECIMENS FROM COLD SPRING FOUNDRY.

[Samples of metal used for life-saving guns.]

No. 157.

Tension test.

Marks on bar, 27.
Length, 3″.
Diameter, ″.564.
Sectional area .25 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
250	1, 000	0.	....	0.	....	Initial load.
500	2, 000	.000100	.000100	0.	....	
750	3, 000	.000233	.000133	.000033	.000033	
1, 000	4, 000	.000300	.000067	.000033	0.	
1, 250	5, 000	.000367	.000067	.000067	.000034	
1, 500	6, 000	.000433	.000066	.000067	0.	
1, 750	7, 000	.000567	.000134	.000067	0.	
2, 000	8, 000	.000600	.000033	.000067	0.	
2, 250	9, 000	.000667	.000067	.000100	.000033	
2, 500	10, 000	.000800	.000133	.000133	.000033	
2, 750	11, 000	.000867	.000067	.000133	0.	
3, 000	12, 000	.000967	.000100	.000167	.000034	Elastic limit.
3, 250	13, 000	.001033	.000066	.000233	.000033	
3, 500	14, 000	.001233	.000200	.000300	.000067	
3, 750	15, 000	.001333	.000100	.000333	.000033	
4, 000	16, 000	.001633	.000300	.000567	.000234	
4, 250	17, 000	.001933	.000300	.000733	.000166	
4, 500	18, 000	.002300	.000367	.001033	.000300	
4, 750	19, 000	.003033	.000733	.001833	.000800	
5, 000	20, 000	.004133	.001100	.002900	.001067	
5, 250	21, 000	.006067	.001934	.004633	.001733	
5, 500	22, 000	.009400	.003333	.007867	.003234	
5, 750	23, 000	.011233	.001833	.010033	.002166	
6, 000	24, 000	.013300	.002067	.014900	.004867	
6, 250	25, 000	.022300	.009000	.020733	.005833	
6, 500	26, 000	.028967	.006667	.027000	.006267	
6, 750	27, 000	.036633	.007666	.034167	.007167	
7, 000	28, 000	.048300	.011667	.045433	.011266	
7, 250	29, 000	.056567	.008267	.053600	.008167	
7, 500	30, 000	.067467	.010900	.064300	.010700	
7, 750	31, 000	.0733	.005833	....	....	Micrometer removed.
8, 000	32, 000	.0867	.0134	....	....	
8, 250	33, 000	.0933	.0066	....	....	
8, 500	34, 000	.1133	.0200	....	....	
8, 750	35, 000	.1233	.0100	....	....	
9, 000	36, 000	.1367	.0134	....	....	
9, 250	37, 000	.1500	.0133	....	....	
9, 500	38, 000	.1600	.0100	....	....	
9, 750	39, 000	.1800	.0200	....	....	
10, 000	40, 000	.1967	.0167	....	....	
10, 250	41, 000	.2167	.0200	....	....	
10, 500	42, 000	.2400	.0233	....	....	
10, 750	43, 000	.2633	.0233	....	....	
10, 880	43, 520	....	....	....	....	Ultimate strength.

General summary.

Specific gravity	8.581
Hardness	5.270
Tensile strength per square inch of original section ... pounds	43,520
Elastic limit per square inch of original section ... do	12,000
Elongation per inch after rupture ... inch	0.28
Elongation per inch under strain at elastic limit ... do	.000967
Reduction in diameter at point of rupture ... do	.084
Reduction in area after rupture, per centum of original section	28.0
Position of rupture	middle of stem.
Character of broken surface	light yellow, slight variation in color.
Elongation of inch sections	″.26 (″.32 fractured section), ″.28.

No. 152.

Tension test.

Marks on bar, 33.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.		0.		Initial load.
1,000	2,000	.000025	.000025	0.		
1,500	3,000	.000075	.000050	0.		
2,000	4,000	.000125	.000050	0.		
2,500	5,000	.000175	.000050	0.		
3,000	6,000	.000225	.000050	0.		
3,500	7,000	.000250	.000025	0.		
4,000	8,000	.000300	.000050	.000025	.000025	
4,500	9,000	.000350	.000050	.000025	0.	
5,000	10,000	.000400	.000050	.000025	0.	
5,500	11,000	.000450	.000050	.000025	0.	
6,000	12,000	.000525	.000075	.000025	0.	
6,500	13,000	.000550	.000025	.000025	0.	
7,000	14,000	.000650	.000100	0.	.000025	
7,500	15,000	.000725	.000075	0.	0.	Elastic limit.
8,000	16,000	.000825	.000100	.000025	.000025	
8,500	17,000	.001000	.000175	.000100	.000075	
9,000	18,000	.001125	.000125	.000175	.000075	
9,500	19,000	.001325	.000200	.000300	.000125	
10,000	20,000	.001625	.000300	.000575	.000275	
10,500	21,000	.002275	.000650	.001250	.000675	
11,000	22,000	.003475	.001200	.002425	.001175	
11,500	23,000	.005825	.002350	.004675	.002250	
12,000	24,000	.010250	.004425	.009050	.004375	
12,500	25,000	.014200	.003950	.012800	.003750	
13,000	26,000	.020000	.005800	.018450	.005650	
13,500	27,000	.025950	.005950	.024400	.005950	
14,000	28,000	.032375	.006425	.030625	.006225	
14,500	29,000	.040250	.007875	.038425	.007800	
15,000	30,000	.046500	.006250	.044500	.006075	Micrometer removed.
15,500	31,000	.0550	.0085			
16,000	32,000	.0675	.0125			
16,500	33,000	.0750	.0075			
17,000	34,000	.0850	.0100			
17,500	35,000	.0950	.0100			
18,000	36,000	.1050	.0100			
18,500	37,000	.1175	.0125			
19,000	38,100	.1300	.0125			
19,500	39,000	.1450	.0150			
20,000	40,000	.1550	.0100			
20,500	41,000	.1725	.0175			
21,000	42,000	.1875	.0150			
21,500	43,000	.2050	.0175			
22,000	44,000	.2250	.0200			
22,500	45,000	.2425	.0175			
23,000	46,000	.2650	.0225			
23,500	47,000	.2950	.0300			
24,000	48,000	.3125	.0175			
24,500	49,000	.3450	.0325			
25,000	50,000	.3850	.0400			
25,500	51,000	.4250	.0400			
26,000	52,000	.4975	.0725			
26,050	52,100					Ultimate strength.

General summary.

Specific gravity		8.8834
Hardness		6.134
Tensile strength per square inch of original section	pounds..	52,100
Elastic limit per square inch of original section	do...	15,000
Elongation per inch after rupture	inch..	0.512
Elongation per inch under strain at elastic limit	do...	.000725
Reduction in diameter at point of rupture	do...	.198
Reduction in area after rupture, per centum of original section		44.0
Position of rupture		″.5 from middle of stem.
Character of broken surface		uniform structure light yellow color.
Elongation of inch sections		″.50, ″.49 (″.61 fractured section), ″.45.

No. 153.

Tension test.

Marks on bar, 47.
Length, 4".
Diameter, ".798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	0.	....	
1,000	2,000	.000050	.000050	0.	....	
1,500	3,000	.000075	.000025	0.	....	
2,000	4,000	.000125	.000050	0.	....	
2,500	5,000	.000250	.000125	0.	....	
3,000	6,000	.000300	.000050	0.	....	
3,500	7,000	.000350	.000050	0.	....	
4,000	8,000	.000450	.000100	.000025	.000025	
4,500	9,000	.000500	.000050	.000025	0.	
5,000	10,000	.000550	.000125	.000025	0.	
5,500	11,000	.000675	.000125	.000025	0.	
6,000	12,000	.000725	.000050	.000050	.000025	
6,500	13,000	.000775	.000050	.000050	0.	Elastic limit.
7,000	14,000	.000900	.000125	.000100	.000050	
7,500	15,000	.001025	.000125	.000175	.000075	
8,000	16,000	.001175	.000150	.000275	.000100	
8,500	17,000	.001525	.000350	.000525	.000250	
9,000	18,000	.001800	.000275	.000775	.000250	
9,500	19,000	.002575	.000775	.001475	.000700	
10,000	20,000	.004025	.001450	.002925	.001450	
10,500	21,000	.006225	.002200	.004975	....	
11,000	22,000	.009775	.003550	.008575	....	
11,500	23,000	.014350	.004575	.013025	....	
12,000	24,000	.021400	.007050	.019775	....	
12,500	25,000	.028275	.006875	.026450	....	
13,000	26,000	.033400	.005125	.031525	....	
13,500	27,000	.042525	.009125	.040375	....	
14,000	28,000	.052525	.010000	.050275	....	
14,500	29,000	.058525	.006000	.056200	....	
15,000	30,000	.069775	.011250	.067200	....	Micrometer removed.
15,500	31,000	.0850	.015225	....	....	
16,000	32,000	.0925	.0075	....	....	
16,500	33,000	.1000	.0075	....	....	
17,000	34,000	.1150	.0150	....	....	
17,500	35,000	.1275	.0125	....	....	
18,000	36,000	.1425	.0150	....	....	
18,500	37,000	.1550	.0125	....	....	
19,000	38,000	.1725	.0175	....	....	
19,500	39,000	.1875	.0150	....	....	
20,000	40,000	.2075	.0200	....	....	
20,500	41,000	.2275	.0200	....	....	
21,000	42,000	.2500	.0225	....	....	
21,500	43,000	.2725	.0225	....	....	
22,000	44,000	.3075	.0350	....	....	
22,350	44,700	....	....	....	....	Ultimate strength.

General summary.

Specific gravity	8.6322
Hardness	5.375
Tensile strength per square inch of original section ......pounds..	44,700
Elastic limit per square inch of original section ......do ...	13,000
Elongation per inch after rupture ......inch..	0.32
Elongation per inch under strain at elastic limit ......do...	.000775
Reduction in diameter at point of rupture	broke at neck.
Reduction in area after rupture, per centum of original section	00.0
Position of rupture	at neck.
Character of broken surface	porous, spongy. Numerous fine cracks developed along the surface of the stem.
Elongation of inch section	".29, ".31, ".32 (".36 fractured section).

No. 149.

Tension test.

Marks on bar, 49.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1, 000	0.	....	0.	....	Initial load.
1, 000	2, 000	.000075	.000075	0.	....	
1, 500	3, 000	.000100	.000025	0.	....	
2, 000	4, 000	.000150	.000050	0.	....	
2, 500	5, 000	.000225	.000075	0.	....	
3, 000	6, 000	.000275	.000050	0.	....	
3, 500	7, 000	.000325	.000050	0.	....	
4, 000	8, 000	.000375	.000050	0.	....	
4, 500	9, 009	.000425	.000050	0.	....	
5, 000	10, 000	.000500	.000075	0.	....	
5, 500	11, 000	.000550	.000050	0.	....	
6, 000	12, 000	.000600	.000050	0.	....	
6, 500	13, 000	.000625	.000025	0.	....	
7, 000	14, 000	.000675	.000050	0.	....	Elastic limit.
7, 500	15, 000	.000825	.000150	.000075	.000075	
8, 000	16, 000	.000900	.000075	.000125	.000050	
8, 500	17, 000	.001100	.000200	.000250	.000125	
9, 000	18, 000	.001300	.000200	.000375	.000125	
9, 500	19, 000	.001575	.000275	.000600	.000225	
10, 000	20, 000	.002100	.000525	.001125	.000525	
10, 500	21, 000	.003800	.001700	.002850	.001725	
11, 000	22, 000	.005325	.001525	.004400	.001550	
11, 500	23, 000	.010100	.004775	.008900	.004500	
12, 000	24, 000	.014250	.004150	.013050	.004150	
12, 500	25, 000	.019525	.005275	.018100	.005050	
13, 000	26, 000	.025325	.005800	.024325	.006225	
13, 500	27, 000	.032575	.006750	.030825	.006500	
14, 000	28, 000	.039325	.006750	.037575	.006750	
14, 500	29, 000	.046000	.006675	.044100	.006525	
15, 000	30, 000	.053575	.007575	.051525	.007425	Micrometer removed.
15, 500	31, 000	.0625	.008925	....	....	
16, 000	32, 000	.0700	.0075	....	....	
16, 500	33, 000	.0800	.0100	....	....	
17, 000	34, 000	.0900	.0100	....	....	
17, 500	35, 000	.1000	.0100	....	....	
18, 000	36, 000	.1125	.0125	....	....	
18, 500	37, 000	.1225	.0100	....	....	
19, 000	38, 000	.1350	.0125	....	....	
19, 500	39, 000	.1475	.0125	....	....	
20, 000	40, 000	.1600	.0125	....	....	
20, 500	41, 000	.1700	.0100	....	....	
21, 000	42, 000	.1925	.0225	....	....	
21, 500	43, 000	.2025	.0100	....	....	
22, 000	44, 000	.2250	.0225	....	....	
22, 500	45, 000	.2450	.0200	....	....	
23, 000	46, 000	.2675	.0225	....	....	
23, 500	47, 000	.2900	.0225	....	....	
24, 000	48, 000	.3175	.0275	....	....	
24, 500	49, 000	.3575	.0400	....	....	
25, 000	50, 000	.3925	.0350	....	....	
25, 500	51, 000	.4450	.0525	....	....	
25, 580	51, 160	....	....	....	....	Ultimate strength.

General summary.

Specific gravity	8.8949
Hardness	7.161
Tensile strength per square inch of original section ....pounds..	51, 160
Elastic limit per square inch of original section ....do....	14, 000
Elongation per inch after rupture ....inch..	0.46
Elongation per inch under strain at elastic limit ....do....	.000675
Reduction in diameter at point of rupture (approximate)	.188
Reduction in area after rupture, per centum of original section	42.0
Position of rupture	1″ 3 from neck.
Character of broken surface	uniform structure, light yellow color.
Elongation of inch sections	(″.54 fractured section), ″.45, ″.43, ″.42

No. 155.

Tension test.

Marks on bar, 63.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1, 000	0.	....	0.	....	Initial load.
1, 000	2, 000	.000050	.000050	0.	....	
1, 500	3, 000	.000125	.000075	0.	....	
2, 000	4, 000	.000200	.000075	0.	....	
2, 500	5, 000	.000275	.000075	0.	....	
3, 000	6, 000	.000375	.000100	—.000025	—.000025	
3, 500	7, 000	.000425	.000050	—.000025	0.	
4, 000	8, 000	.000475	.000050	—.000025	0.	
4, 500	9, 000	.000550	.000075	0.	.000025	Elastic limit.
5, 000	10, 000	.000650	.000100	.000025	.000025	
5, 500	11, 000	.000750	.000100	.000050	.000025	
6, 000	12, 000	.000850	.000100	.000100	.000050	
6, 500	13, 000	.000925	.000075	.000150	.000050	
7, 000	14, 000	.001175	.000250	.000275	.000125	
7, 500	15, 000	.001425	.000250	.000475	.000200	
8, 000	16, 000	.001900	.000475	.000900	.000425	
8, 500	17, 000	.002700	.000800	.001650	.000750	
9, 000	18, 000	.004275	.001575	.003150	.001500	
9, 500	19, 000	.006525	.002250	.005400	.002250	
10, 000	20, 000	.011525	.005000	.010825	.004925	
10, 500	21, 000	.016900	.005375	.015525	.005200	
11, 000	22, 000	.023900	.007000	.022550	.007025	
11, 500	23, 000	.031100	.007200	.029400	.006850	
12, 000	24, 000	.040575	.009475	.038725	.009325	
12, 500	25, 000	.048400	.007825	.046600	.007875	
13, 000	26, 000	.059900	.011500	.057825	.011225	
13, 500	27, 000	.065900	.006000	.066275	.008450	
14, 000	28, 000	.080400	.014500	.078200	.011925	
14, 500	29, 000	.091325	.010925	.088650	.010450	
15, 000	30, 000	.106100	.014775	.103150	.014500	Micrometer removed.
15, 500	31, 000	.1225	.0164	....	....	
16, 000	32, 000	.1350	.0125	....	....	
16, 500	33, 000	.1500	.0150	....	....	
17, 000	34, 000	.1625	.0125	....	....	
17, 500	35, 000	.1925	.0300	....	....	
17, 950	35, 900	....	....	....	....	Ultimate strength.

General summary.

Specific gravity	8.3696
Hardness	4.781
Tensile strength per square inch of original section ....pounds..	35, 900
Elastic limit per square inch of original section ....do...	9, 000
Elongation per inch after rupture ....inch..	0.217
Elongation per inch under strain at elastic limit ....do...	.000550
Reduction in diameter at point of rupture ....do...	.088
Reduction in area after rupture, per centum of original section	20.0

Position of rupture ....″.2 from middle of stem.
Character of broken surface........spongy; color, light yellow, with spots of dark yellow and copper-colored metal; surface of stem cracked.
Elongation of inch sections......................................″.20, .″20 (″.29 fractured section), ″.18

No. 154.

Tension test.

Marks on bar, 71.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	0.	....	Initial load.
1,000	2,000	.000050	.000050	0.	....	
1,500	3,000	.000100	.000050	0.	....	
2,000	4,000	.000150	.000050	0.	....	
2,500	5,000	.000200	.000050	0.	....	
3,000	6,000	.000250	.000050	0.	....	
3,500	7,000	.000300	.000050	0.	....	
4,000	8,000	.000350	.000050	0.	....	
4,500	9,000	.000425	.000075	0.	....	
5,000	10,000	.000475	.000050	0.	....	
5,500	11,000	.000525	.000050	0.	....	
6,000	12,000	.000625	.000100	0.	....	
6,500	13,000	.000725	.000100	.000025	.000025	
7,000	14,000	.000775	.000050	.000025	0.	Elastic limit.
7,500	15,000	.000925	.000150	.000125	0.	
8,000	16,000	.001075	.000150	.000225	.000200	
8,500	17,000	.001250	.000175	.000350	.000125	
9,000	18,000	.001525	.000275	.000575	.000225	
9,500	19,000	.001925	.000400	.000925	.000350	
10,000	20,000	.003000	.001075	.001975	.001050	
10,500	21,000	.004750	.001750	.003650	.001675	
11,000	22,000	.006550	.001800	.005450	.001800	
11,500	23,000	.009875	.003325	.008700	.003250	
12,000	24,000	.014000	.004125	.012675	.003975	
12,500	25,000	.019200	.005200	.017725	.005050	
13,000	26,000	.022875	.003675	.021250	.003525	
13,500	27,000	.028250	.005375	.026750	.005500	
14,000	28,000	.035250	.007000	.033475	.006725	
14,500	29,000	.042625	.007375	.040650	.007175	
15,000	30,000	.050950	.008325	.048800	.008150	Micrometer removed.
15,500	31,000	.0575	.006550	....	....	
16,000	32,000	.0675	.0100	....	....	
16,500	33,000	.0750	.0075	....	....	
17,000	34,000	.0850	.0100	....	....	
17,500	35,000	.0950	.0100	....	....	
18,000	36,000	.1050	.0100	....	....	
18,500	37,000	.1175	.0125	....	....	
19,000	38,000	.1275	.0100	....	....	
19,500	39,000	.1375	.0100	....	....	
20,000	40,000	.1525	.0150	....	....	
20,500	41,000	.1700	.0175	....	....	
21,000	42,000	.1875	.0175	....	....	Surface cracks developed.
21,500	43,000	.2000	.0125	....	....	
22,000	44,000	.2200	.0200	....	....	
22,500	45,000	.2400	.0200	....	....	
23,000	46,000	.2650	.0250	....	....	
23,500	47,000	.2925	.0275	....	....	
23,900	47,800	....	....	....	....	Ultimate strength.

General summary.

Specific gravity		8.9852
Hardness		6.711
Tensile strength per square inch of original section	pounds..	47,800
Elastic limit per square inch of original section	do....	14,000
Elongation per inch after rupture	inch..	0.33
Elongation per inch under strain at elastic limit	do....	.000775
Reduction in diameter at point of rupture	do....	.148
Reduction in area after rupture, per centum of original section		34.0

Position of rupture ....1″.5 from neck.
Character of broken surface.......yellow-gray color; small spongy spot at circumference of fracture. Cracks developed along the stem.
Elongation of inch sections....................″.31, ″.31 (″.38 fractured section), ″.33.

No. 150.—*Tension test.*

Marks on bar, 73.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	0.	....	Initial load.
1,000	2,000	.000050	.000050	0.	....	
1,500	3,000	.000125	.000075	0.	....	
2,000	4,000	.000200	.000075	0.	....	
2,500	5,000	.000250	.000050	.000025	.000025	
3,000	6,000	.000300	.000050	.000025	0.	
3,500	7,000	.000400	.000100	.000025	0.	
4,000	8,000	.000500	.000100	.000025	0.	
4,500	9,000	.000525	.000025	.000025	0.	
5,000	10,000	.000600	.000075	.000025	0.	Elastic limit.
5,500	11,000	.000700	.000100	.000075	.000050	
6,000	12,000	.000750	.000050	.000100	.000025	
6,500	13,000	.000850	.000100	.000150	.000050	
7,000	14,000	.000975	.000125	.000200	.000050	
7,500	15,000	.001025	.000050	.000225	.000025	
8,000	16,000	.001175	.000150	.000300	.000075	
8,500	17,000	.001350	.000175	.000400	.000100	
9,000	18,000	.001550	.000200	.000525	.000125	
9,500	19,000	.001850	.000300	.000750	.000225	
10,000	20,000	.002250	.000400	.001025	.000275	
10,500	21,000	.002825	.000575	.001650	.000625	
11,000	22,000	.003875	.001050	.002750	.001100	
11,500	23,000	.005050	.001175	.003775	.001025	
12,000	24,000	.007025	.001975	.005750	.001975	
12,500	25,000	.009825	.002800	.008400	.002650	
13,000	26,000	.012750	.002925	.011175	.002775	
13,500	27,000	.014550	.001800	.013025	.001850	
14,000	28,000	.019500	.004950	.017800	.004775	
14,500	29,000	.024125	.004625	.022175	.004375	
15,000	30,000	.030000	.005875	.027850	.005675	Micrometer removed.
15,500	31,000	.0350	.0050	....	....	
16,000	32,000	.0400	.0050	....	....	
16,500	33,000	.0450	.0050	....	....	
17,000	34,000	.0575	.0125	....	....	
17,500	35,000	.0625	.0050	....	....	
18,000	36,000	.0700	.0075	....	....	
18,500	37,000	.0800	.0100	....	....	
19,000	38,000	.0875	.0075	....	....	
19,500	39,000	.1000	.0125	....	....	
20,000	40,000	..1125	.0125	....	....	
20,500	41,000	.1200	.0075	....	....	
21,000	42,000	.1325	.0125	....	....	
21,500	43,000	.1500	.0175	....	....	
22,000	44,000	.1600	.0100	....	....	
22,500	45,000	.1825	.0225	....	....	
23,000	46,000	.2000	.0175	....	....	
23,500	47,000	.2200	.0200	....	....	
24,000	48,000	.2450	.0250	....	....	
24,500	49,000	.2750	.0300	....	....	
25,000	50,000	.3075	.0325	....	....	
25,500	51,000	.3475	.0400	....	....	
25,700	51,400	....	....	....	....	Ultimate strength.

General summary.

Specific gravity		8.8359
Hardness		7.402
Tensile strength per square inch of original section	pounds..	51,400
Elastic limit per square inch of original section	do	10,000
Elongation per inch after rupture	inch..	0.357
Elongation per inch under strain at elastic limit	do....	.000600
Reduction in diameter at point of rupture	do....	.136
Reduction in area after rupture, per centum of original section		32.0

Position of rupture .... ″.5 from neck.
Character of broken surface ....yellowish gray; surface cracks developed along the stem.
Elongation of inch sections ....(″.41 fractured section), ″.35, ″.34, ″.32.

The stem preserved its cylindrical form during the test, not drawing down and making an irregular surface, characteristic of the more ductile specimens.

No. 156.

Tension test.

Marks on bar, 95.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	0.	....	Initial load.
1,000	2,000	.000075	.000075	0.	....	
1,500	3,000	.000125	.000050	0.	....	
2,000	4,400	.000225	.000100	0.	....	
2,500	5,000	.000275	.000050	0.	....	
3,000	6,000	.000300	.000025	0.	....	
3,500	7,000	.000350	000050	0.	....	
4,000	8,000	.000425	.000075	0.	....	
4,500	9,000	.000500	.000075	0.	....	
5,000	10,000	.000550	.000050	0.	....	
5,500	11,000	.000625	.000075	0.	....	Elastic limit.
6,000	12,000	.000725	.000100	.000050	.000050	
6,500	13,000	.000775	.000050	.000175	.000025	
7,000	14,000	.000900	.000125	.000175	.000100	
7,500	15,000	.001000	.000100	.000250	.000075	
8,000	16,000	.001300	.000300	.000375	.000125	
8,500	17,000	.001525	.000225	.000550	.000175	
9,000	18,000	.002075	.000550	.001050	.000500	
9,500	19,000	.002950	.000875	.001850	.000800	
10,000	20,000	.005050	.002100	.004000	.002150	
10,500	21,000	.007675	.002625	.006500	.002500	
11,000	22,000	.012200	.004525	.010925	.004425	
11,500	23,000	.016050	.003850	.014700	.003775	
12,000	24,000	.021250	.005200	.019750	.005050	
12,500	25,000	.028000	.006750	.026375	.006625	
13,000	26,000	.036075	.008075	.034250	.007875	
13,500	27,000	.041500	.005425	.039525	.005275	
14,000	28,000	.049075	.007575	.047000	.007475	
14,500	29,000	.057500	.008425	.055300	.008300	
15,000	30,000	.066875	.009375	.064625	.009325	Micrometer removed.
15,500	31,000	.0750	.008125	....	....	
16,000	32,000	.0850	.0100	....	....	
16,500	33,000	.0950	.0100	....	....	
17,000	34,000	.1050	.0100	....	....	
17,500	35,000	.1175	.0125	....	....	
18,000	36,000	.1325	.0150	....	....	
18,500	37,000	.1425	.0100	....	....	
19,000	38,000	.1550	.0125	....	....	
19,500	39,000	.1750	.0200	....	....	
20,000	40,000	.1925	.0175	....	....	
20,500	41,000	.2125	.0200	....	....	
21,000	42,000	.2325	.0200	....	....	
21,500	43,000	.2600	.0275	....	....	
21,840	43,680	....	....	....	....	Ultimate strength.

General summary.

Specific gravity		8.7650
Hardness		5.322
Tensile strength per square inch of original section	pounds..	43,680
Elastic limit per square inch of original section	do....	11,000
Elongation per inch after rupture	inch....	0.277
Elongation per inch under strain at elastic limit	do....	.000625
Reduction in diameter at point of rupture	do....	.128
Reduction in area after rupture, per centum of original section		30.0
Position of rupture		1″.5 from neck.
Character of broken surface		slightly spongy; variations of color.

Fracture began at side, showing small copper-colored spots, and light-gray metal. This side of the stem was broken with surface cracks.

No. 151.

Tension test.

Marks on bar, 97.
Length, 4″.
Diameter, ″.798.
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	0.	....	Initial load.
1.000	2,000	.000050	.000050	0.	....	
1,500	3,000	.000125	.000075	0.	....	
2,000	4,000	.000175	.000050	0.	....	
2,500	5,000	.000250	.000075	0.	....	
3,000	6,000	.000275	.000025	0.	....	
3,500	7,000	.000325	.000050	0.	....	
4,000	8,000	.000375	.000050	0.	....	
4,500	9,000	.000450	.000075	0.	....	
5,000	10,000	.000500	.000050	0.	....	
5,500	11,000	.000550	.000050	0.	....	
6,000	12,000	.000625	.000075	0.	....	
6,500	13,000	.000700	.000075	0.	....	Elastic limit.
7,000	14,000	.000775	.000075	.000025	.000025	
7,500	15,000	.000875	.000100	.000075	.000050	
8,000	16,000	.001025	.000150	.000200	.000125	
8,500	17,000	.001250	.000225	.000300	.000100	
9,000	18,000	.001500	.000250	.000525	.000225	
9,500	19,000	.001800	.000300	.000875	.000350	
10,000	20,000	.002525	.000725	.001550	.000675	
10,500	21,000	.003950	.001425	.003050	.001500	
11,000	22,000	.006275	.002325	.005225	.002175	
11,500	23,000	.010050	.003775	.008950	.003725	
12,000	24,000	.014975	.004925	.013750	.004800	
12,500	25,000	.020525	.005550	.019025	.005275	
13,000	26,000	.026475	.005950	.025025	.006000	
13,500	27,000	.032025	.005550	.030525	.005500	
14,000	28,000	.040025	.008000	.038225	.007700	
14,500	29,000	.047275	.007250	.045525	.007300	
15,000	30,000	.055525	.008250	.053425	.007900	Micrometer removed.
15,500	31,000	.0650	.009475	....	....	
16,000	32,000	.0725	.0075	....	....	
16,500	33,000	.0800	.0075	....	....	
17,000	34,000	.0925	.0125	....	....	
17,500	35,000	.1025	.0100	....	....	
18,000	36,000	.1125	.0100	....	....	
18,500	37,000	.1250	.0125	....	....	
19,000	38,000	.1375	.0125	....	....	
19,500	39,000	.1525	.0150	....	....	
20,000	40,000	.1650	.0125	....	....	
20,500	41,000	.1825	.0175	....	....	
21,000	42,000	.2000	.0175	....	....	
21,500	43,000	.2200	.0200	....	....	
22,000	44,000	.2375	.0175	....	....	
22,500	45,000	.2625	.0250	....	....	
23,000	46,000	.2850	.0225	....	....	
23,500	47,000	.3125	.0275	....	....	
24,000	48,000	.3475	.0350	....	....	
24,500	49,000	.3875	.0400	....	....	
25,000	50,000	.4375	.0500	....	....	
25,490	50,980	....	....	....	....	Ultimate strength.

General summary.

Specific gravity	8.8212
Hardness	6.072
Tensile strength per square inch of original section ....pounds..	50,980
Elastic limit per square inch of original section ....do....	13,000
Elongation per inch after rupture ....inch..	0.51
Elongation per inch under strain at elastic limit ....do....	.000700
Reduction in diameter at point of rupture ....do....	.178
Reduction in area after rupture, per centum of original section	40.0
Position of rupture	2″ from neck.
Character of broken surface	light-yellow colored, interspersed with small spots of dark-yellow metal.
Elongation of inch sections	″.53, ″.49 (″.56 fractured section), ″.46.

No. 131.

Tension test.

Marks on bar, 99.
Length, 4″.
Diameter, ″.798
Sectional area, .50 square inch.

Applied loads.		Elongation per inch.	Successive elongation per inch.	Permanent set.	Successive permanent set.	Remarks.
Total.	Per square inch.					
Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	
500	1,000	0.	....	0.	....	Initial load.
1,000	2,000	.000075	.000075	0.	....	
1,500	3,000	.000150	.900075	0.	....	
2,000	4,400	.000200	.000050	0.	....	
2,500	5,000	.000250	.000050	0.	....	
3,000	6,000	.000300	.000050	0.	....	
3,500	7,000	.000375	.000075	0.	....	
4,000	8,000	.000475	.000100	0.	....	
4,500	9,000	.000475	0.	0.	....	
5,000	10,000	.000525	.000050	0.	....	
5,500	11,000	.000550	.000025	0.	....	
6,000	12,000	.000625	.000075	0.	....	
6,500	13,000	.000750	.000125	0.	....	
7,000	14,000	.000800	.000050	0.	....	Elastic limit.
7,500	15,000	.000950	.000150	.000075	.000075	
8,000	16,000	.001200	.000250	.000225	.000150	
8,500	17,000	.001475	.000275	.000425	.000200	
9,000	18,000	.001975	.000500	.000800	.000375	
9,500	19,000	.002925	.000950	.001750	.000950	
10,000	20,000	.004725	.001800	.003525	.001775	
10,500	21,000	.007975	.003250	.006775	.003250	
11,000	22,000	.014925	.006950	.013475	.006700	
11,500	23,000	.019700	.004775	.018075	.004600	
12,000	24,000	.026225	.006525	.026225	.008150	
12,500	25,000	.032625	.006400	.032625	.006400	
13,000	26,000	.040375	.007750	.040375	.007750	
13,500	27,000	.047975	007600	.047975	.007600	
14,000	28,000	.056425	008850	.056425	.008450	
14,500	29,000	.065225	.008800	.065225	.008800	
15,000	30,000	.074525	.009300	.074525	.009300	Micrometer removed.
15,500	31,000	.0875	.012975	....	....	
16,000	32,000	.1000	.0125	....	....	
16,500	33,000	.1125	.0125	....	....	
17,000	34,000	.1250	.0125	....	....	
17,500	35,000	.1375	.0125	....	....	
18,000	36,000	.1500	.0125	....	....	
18,500	37,000	.1650	.0150	....	....	
19,000	38,000	.1800	.0150	....	....	
19,500	39,000	.2000	.0200	....	....	
20,000	40,000	.2175	.0175	....	....	
20,500	41,000	.2400	.0225	....	....	
21,000	42,000	.2600	.0200	....	....	
21,500	43,000	.2875	.0275	....	....	
22,000	44,000	.3200	.0325	....	....	
22,050	44,100	....	....	....	....	Ultimate strength.

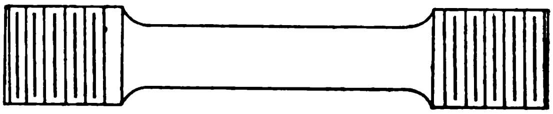
General summary.

Specific gravity		8.5916
Hardness		5.116
Tensile strength per square inch of original section	pounds..	44,100
Elastic limit per square inch of original section	do ...	14,000
Elongation per inch after rupture	inch..	0.333
Elongation per inch under strain at elastic limit	do....	.000800
Reduction in diameter at point of rupture (approximate)	do....	.148
Reduction in area after rupture, per centum of original section		34.0
Position of rupture		1″.75 from neck
Character of broken surface		light yellow, uniform color; fine surface cracks along the stem.
Elongation of inch sections		″.26, ″.30, (″.41 fractured section), ″.36.

NOTE.—In determining the hardness of the foregoing bronze specimens, a pyramidal indenting tool was used employing pressures of 5,000 pounds on account of the smallness of the specimens. The results were reduced by computation to hardness under 10,000 pounds pressure, assuming that the indentations vary as the square roots of the cubes of the pressures.

BRONZE FROM OLD 6-POUNDER GUNS.

Form of specimens.



No. 11.

[Specimen cut from 6-pounder gun 1839. Cast by Cyrus Alger & Co.]

Diameter of part tested, ″.621.
Sectional area, .303 square inches.
Gauged length, 3″.293.

Applied loads.		Elongation.	Sets.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
303	1, 000	0.	....	Gaugings taken with vernier calipers.
606	2, 000	.001	....	
909	3, 000	.001 +	....	There were numerous blow-holes in the specimen which were visible before the test began.
1, 212	4, 000	.002	....	
1, 515	5, 000	.002	....	
1, 818	6, 000	.002+	....	
2, 121	7, 000	.003	....	
2, 424	8, 000	.003	....	
2, 727	9, 000	.003	....	
3, 030	10, 000	.003	....	
3, 333	11, 000	.003½	....	
3, 636	12, 000	.003½	....	
3, 939	13, 000	.004	....	
4, 242	14, 000	.004½	....	
4, 545	15, 000	.005½	....	Elastic limit.
4, 848	16, 000	.011	....	
5, 151	17, 000	.017	....	Irregular surface cracks appear.
5, 454	18, 000	.026	....	
5, 757	19, 000	.052	....	
6, 060	20, 000	.074	....	
6, 363	21, 000	.108	....	
6, 666	22, 000	.143	....	
6, 969	23, 000	.180	....	
7, 185	23, 710	....	....	Ultimate strength.

The surface of the cylindrical part finally divided by irregular cracks.

Fractured ends yellowish copper colored, with distinct spots of light silvery appearance.

Surface vesicular.

No. 12.

[Bronze cut from 6-pounder gun 1839, and recast at Watertown Arsenal.]

Diameter, ″.623.
Sectional area, .305 square inch.
Gauged length, 3″.292.

Applied loads.		Elongation.	Sets.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
305	1,000	0.	....	
610	2,000	0.	....	
915	3,000	.001	....	
1,220	4,000	.001	....	
1,525	5,000	.001½	....	
1,830	6,000	.002	....	
2,135	7,000	.002	....	
2,440	8,000	.002½	....	
2,745	9,000	.003	....	
3,050	10,000	.003	....	
3,355	11,000	.003½	....	
3,660	12,000	.004	....	
3,965	13,000	.004	....	
4,270	14,000	.004½	....	
4,575	15,000	.005	....	
4,880	16,000	.005½	....	Elastic limit.
5,185	17,000	.008	....	
5,490	18,000	.015	....	
5,795	19,000	.026	....	
6,100	20,000	.046	....	
6,405	21,000	.072	....	
6,710	22,000	.101	....	
7,015	23,000	.128	....	
7,320	24,000	.154	....	
7,625	25,000	.185	....	
7,930	26,000	.216	....	
8,235	27,000	.255	....	
8,540	28,000	.291	....	
8,845	29,000	.338	....	
9,150	30,000	.376	....	
9,455	31,000	.419	....	
9,710	31,840	....	....	Ultimate strength.

Fractured at neck of specimen; yellowish copper colored.

The irregular surface of fracture composed of planes, which were covered with a network of fine lines, intersecting each other at right angles.

The apparent dissociation of constituents observed in specimen No. 11 not apparent in this specimen.

No. 13.

[Bronze cut from 6-pounder gun cast by N. P. Ames in 1846.]

Diameter, ″.623.
Sectional area, .305 square inch.
Gauged length, 3″.277.

Applied loads.		Elongation.	Sets.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
305	1,000	0.	....	
610	2,000	.000¼	....	
915	3,000	.000¾	....	
1,220	4,000	.001	....	
1,525	5,000	.001	....	
1,830	6,000	.001	....	
2,135	7,000	.001½	....	
2,440	8,000	.002	....	
2,745	9,000	.002	....	
3,050	10,000	.003	....	
3,355	11,000	.003	....	
3,660	12,000	.003	....	
3,965	13,000	.003½	....	
4,270	14,000	.004	....	
4,575	15,000	.004½	....	
4,880	16,000	.006	....	Elastic limit.
5,185	17,000	.009	....	
5,490	18,000	.016	....	
5,795	19,000	.030	....	Irregular surface cracks appear.
6,100	20,000	.055	....	
6,405	21,000	.088	....	
6,680	21,900	....	....	Ultimate strength.

Fifty per cent. of fracture yellowish copper colored, 50 per cent. light gray.

Fracture irregular. Surface vesicular.

The apparent dissociation of constituents more strongly marked than observed in specimen No. 77.

Cylindrical surface divided by numerous irregular cracks.

No. 14.

[Bronze cut from old 6-pounder gun, 1846; recast at Watertown Arsenal.]

Diameter, ″.623.
Sectional area, .305 square inch.
Gauged length, 3″.292.
Surface of specimen porous.

Applied loads.		Elongation.	Sets.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
305	1,000	0.	....	
610	2,000	0.	....	
915	3,000	.001	....	
1,220	4,000	.001½	....	
1,525	5,000	.002	....	
1,830	6,000	.003	....	
2,135	7,000	.003	....	
2,440	8,000	.003½	....	
2,745	9,000	.004	....	
3,050	10,000	.004	....	
3,355	11,000	.004½	....	Elastic limit.
3,660	12,000	.006	....	
3,965	13,000	.007	....	
4,270	14,000	.008	....	
4,575	15,000	.010	....	
4,880	16,000	.015	....	
5,185	17,000	.021	....	
5,490	18,000	.036	....	Surface cracks appear.
5,795	19,000	.057	....	
6,020	19,740	....	....	Ultimate strength.

Forty per cent. of fracture yellowish copper colored; 60 per cent. light gray. Fracture irregular, surface vesicular.

Apparent dissociation of constituents; cylindrical surface divided by short irregular fissures.

No. 18.

[Bronze cut from old 6-pounder gun, A.]

Diameter, ''.626.
Sectional area, ''.308 square inch.
Gauged length, 3''.283.

Applied loads.		Elongation.	Sets.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
308	1,000	0.	....	
616	2,000	0.	....	
924	3,000	.001	....	
1,232	4,000	.001	....	
1,540	5,000	.001¼	....	
1,848	6,000	.001¾	....	
2,156	7,000	.002	....	
2,464	8,000	.002¼	....	
2,772	9,000	.002¾	....	
3,080	10,000	.003	....	
3,388	11,000	.003½	....	
3,696	12,000	.004	....	
4,004	13,000	.004½	....	
4,312	14,000	.005	....	Elastic limit.
4,620	15,000	.006	....	
4,928	16,000	.007	....	
5,236	17,000	.009	....	
5,544	18,000	.012	....	
5,852	19,000	.018	....	
6,160	20,000	.027	....	
6,468	21,000	.037	....	
6,776	22,000	.055	....	
7,084	23,000	.076	....	Irregular surface cracks appear.
7,392	24,000	.101	....	
7,580	24,450	....	....	Ultimate strength.

Color of fracture, yellowish drab; irregular surface, vesicular.

No. 19.

[Recast metal from 6-pounder gun A, first melting.]

Diameter, ″.626.
Sectional area, ″.308 square inch.
Gauged length, 3″.293.

Applied loads.		Elongation.	Sets.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
308	1,000	0.		
616	2,000	.001		
924	3,000	.002		
1,232	4,000	.002		
1,540	5,000	.002		
1,848	6,000	.002¼		
2,156	7,000	.002½		
2,464	8,000	.003		
2,772	9,000	.003		
3,080	10,000	.003¼		
3,388	11,000	.003½		
3,696	12,000	.004		
4,004	13,000	.004		
4,312	14,000	.005		
4,620	15,000	.005¼		
4,928	16,000	.005½		Elastic limit.
5,236	17,000	.010		
5,544	18,000	.017		
5,852	19,000	.020		Surface cracks developed.
6,160	20,000	.033		
6,468	21,000	.049		
6,776	22,000	.066		
7,084	23,000	.084		
7,392	24,000	.108		
7,700	25,000	.140		
7,990	25,940			Ultimate strength.

Irregular fracture, yellowish copper colored.

There was a bright yellow spot near the edge of the fracture, covering about 15 per cent. of the surface.

No. 20.

[Recast metal from old 6-pounder gun A; 2d melting.]

Diameter, ″.626.
Sectional area, ″.308.
Gauged length, 3″.287.

Applied loads.		Elongation.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
308	1,000	0.	....	
616	2,000	.000½	....	
924	3,000	.000¾	....	
1,232	4,000	.001	....	
1,540	5,000	.001	....	
1,848	6,000	.001½	....	
2,156	7,000	.002	....	
2,464	8,000	.002½	....	
2,772	9,000	.003	....	
3,080	10,000	.003	....	
3,388	11,000	.003½	....	
3,696	12,000	.004	....	
4,004	13,000	.004½	....	Elastic limit.
4,312	14,000	.006	....	
4,620	15,000	.007	....	
4,928	16,000	.009	....	
5,236	17,000	.012	....	
5,544	18,000	.018	....	
5,852	19,000	.025	....	
6,160	20,000	.037	....	
6,468	21,000	.053	....	
6,776	22,000	.079	....	Surface cracks developed.
7,084	23,000	.096	....	
7,392	24,000	.121	....	
7,700	25,000	.147	....	
8,008	26,000	.180	....	
8,316	27,000	.212	....	
8,624	28,000	.249	....	
8,780	28,510	....	....	Ultimate strength.

Irregular fracture. Yellowish copper-colored.

No. 21.

[Recast metal from old 6-pounder gun A; 3d melting.]

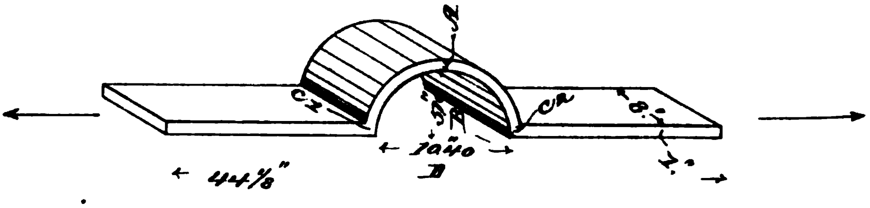
Diameter, ".626.
Sectional area, ".308.
Gauged length, 3".295.

Applied loads.		Elongation.	Set.	Remarks.
Total.	Per square inch.			
Pounds.	*Pounds.*	*Inch.*	*Inch.*	
308	1,000	0.	....	
616	2,000	.000½	....	
924	3,000	.001	....	
1,232	4,000	.001½	....	
1,540	5,000	.002	....	
1,848	6,000	.002¼	....	
2,156	7,000	.002¾	....	
2,464	8,000	.003	....	
2,772	9,000	.003	....	
3,080	10,000	.003¼	....	
3,388	11,000	.003¾	....	
3,696	12,000	.004	....	
4,004	13,000	.004½	....	
4,312	14,000	.005	....	Elastic limit.
4,620	15,000	.007	....	
4,928	16,000	.009½	....	
5,236	17,000	.014	....	
5,544	18,000	.022	....	
5,852	19,000	.032	....	
6,160	20,000	.041	....	Surface cracks developed.
6,468	21,000	.066	....	
6,776	22,000	.082	....	
7,084	23,000	.112	....	
7,392	24,000	.142	....	
7,700	25,000	.172	....	
8,008	26,000	....	....	Ultimate strength.

Irregular fracture. Yellowish copper-colored.

9

Steel strap,
for hydraulic cylinders
Improved Gun carriages.



Smooth forging

S Ex 36 49 1

No. 22.

Tension test.

STEEL STRAP NO. 1.

Dimensions.

A	inch	1.00
B	inches	5.10
C1	do	1.50
C2	do	1.50
D	do	10.40

Total length, 44''.25.
Sectional area, 8''.05×''1=8.05 square inches.
Distance between faces of holders, 32''.5.

Applied loads.	Measurements of—		Remarks.
	Radius B.	Diameter D.	
Pounds.	*Inches.*	*Inches.*	
20,000	5.10	....	Scale starts off of bend at A.
25,000	5.05	....	Corners C depressed ''.2.
30,000	4.98	....	Corners C depressed ''.35.
35,000	4.75	....	Corners C depressed ''.60.
40,000	4.45	....	Corners C depressed ''.85.
50,000	4.00	13.00	Corners C depressed 1''.10.
60,000	3.70	....	Corners C depressed 1''.25.
70,000	3.35	14.00	Corners C depressed 1'' 35.
80,000	3.08	14.40	Corners C depressed 1''.45.
88,000	....	....	Ultimate strength = 10,930 pounds per square inch.

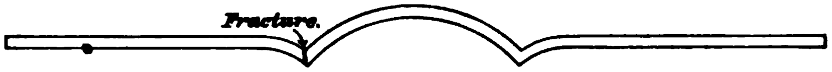
Strap fractured suddenly at C1.

The fracture was short and granular. Along the line of junction of the straight and semi-cylindrical parts on the upper surface, end C, cracks were observed to open under 70,000 pounds tension.

The fracture occurred along this line, and through the cracks thus opened, which from their color showed they were caused during forging.

The metal was granular, varying from fine to coarse, in passing from the upper to the lower surface.

Shape of strap after the test.



No. 23.

Tension test.

STEEL STRAP No. 2.

Dimensions.

A	inch	.95
B	inches	5.10
C1	do	1.45
C2	do	1.45
D	do	10.30

Total length, ″43.
Sectional area, ″8×″.95=7.60 square inches.
Distance between faces of holders, 32″.5.

Applied loads.	Measurements of—		Remarks.
	Radius B.	Diameter D.	
Pounds.	*Inches.*	*Inches.*	
18,000	....	....	Scale starts off of bend at A.
20,000	5.05	10.40	
25,000	5.00	10.70	Corners C depressed ″.25.
30,000	4.85	11.00	Corners C depressed ″.40.
35,000	4.60	11.50	Corners C depressed ″.58.
40,000	4.35	12.15	Corners C depressed ″.75.
50,000	3.85	13.00	Corners C depressed ″1.
60,000	3.48	13.60	Corners C depressed 1″.20.
70,000	3.18	14.10	Corners C depressed 1″.25.
80,000	2.90	14.55	Corners C depressed 1″.29.
90,000	2.65	14.80	Corners C depressed 1″.33.
96,000	....	....	Ultimate strength = 12,640 pounds per square inch.

Fractured suddenly at C1.

The fracture was short and granular, having a radiated appearance, the center of which was near the middle of the upper edge of the fracture.

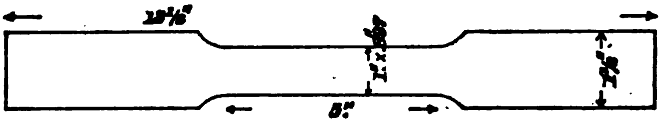
"Lap" marks were opened ″.02 at the junction of the straight and semi-cylindrical parts, end C2.

TENSILE TEST OF MILD STEEL SPECIMEN.

[Same metal as employed in strap No. 1, but not from strap itself.]

No. 15.

Form of specimen.



Sectional area, "1×".897=.897 square inch.

The elastic limit was not well defined. At 26,000 pounds = 28,990 pounds per square inch the rate of elongation began to increase. At 31,000 pounds = 34,560 pounds per square inch rapid elongation was more pronounced.

Ultimate strength, 53,700 pounds = 59,870 pounds per square inch.

Elongation of inch sections: ".19, ".31 (".58 fractured section), ".24, ".19.

Elongation in 5 inches, 1".51=30.2 per cent.

Area at fracture, ".74×".64=.474 square inch.

Contraction of area, 47.2 per cent.

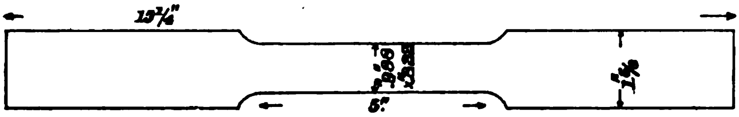
Appearance of fracture, fine silky with slight lamination.

TENSILE TEST OF STEEL SPECIMEN.

[Cut from end C2 of strap No. 2.]

No. 24.

Form of specimen.



Sectional area ".988×".822=.812 square inch.

Decided stretching took place at 35,100 pounds tension = 43,230 pounds per square inch.

Ultimate strength, 55,100 pounds = 67,860 pounds per square inch.

Elongation of inch sections: ".16, ".20, ".25 (".61 fractured section), ".25.

Elongation in 5 inches, 1".47 = 29.4 per cent.

Area at fracture, ".67×".55=.369 square inch.

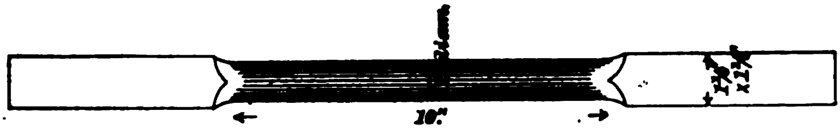
Contraction of area, 54.5 per cent.

Appearance of fracture, fine silky.

10.—TENSION TEST OF TWO BARS O. H. STEEL.

[Furnished by Norway Steel and Iron Company, South Boston, Massachusetts.]

Form of specimen.



No. 16.

Mark on bar, 13-1.
Diameter, 1".000; sectional area, .7854 square inch.
Gauged length, "10.

Applied loads.		Elongation.	Remarks.
Total.	Per square inch.		
Pounds.	*Pounds.*	*Inch.*	
785	1, 000	0.	
7, 854	10, 000	.0029	
15, 708	20, 000	.0061	
19, 635	25, 000	.0078	
23, 562	30, 000	.0098	
27, 489	35, 000	.0116	
31, 416	40, 000	.0133	
35, 343	45, 000	.0159	
39, 270	50, 000	.0182	
40, 055	51, 000	.0188	
40, 841	52, 000	.0192	
41, 626	53, 000	.0198	
42, 412	54, 000	.0204	
43, 197	55, 000	.0210	Elastic limit.
43, 982	56, 000	.0220	
44, 768	57, 000	.0230	
45, 553	58, 000	.0240	
46, 339	59, 000	.0250	
47, 124	60, 000	.0268	
47, 909	61, 000	.0282	
48, 695	62, 000	.0310	
49, 480	63, 000	.0340	
50, 266	64, 000	.0372	
51, 051	65, 000	.0392	
51, 836	66, 000	.0440	
52, 622	67, 000	.0465	
53, 407	68, 000	.0490	
54, 193	69, 000	.0520	Micrometer removed.
54, 978	70, 000	.05¼	
55, 763	71, 000	.05½	
56, 549	72, 000	.05¾	
57, 334	73, 000	.06	
58, 120	74, 000	.06	
58, 905	75, 000	.07	
103, 600	131, 910	....	Ultimate strength.

Elongation after fracture, 1".52 = 15.2 per cent.

Elongation of inch sections: ".09, ".12, ".11, ".12, ".14 (".29, fractured section ".30), ".13, ".13, ".09.

Diameter at fracture, ".80.

Area, .5026 square inch.

Contraction of area, 36 per cent.

Appearance of fracture: granular, radiating from a dull spot "⅛ eccentric. Broke square across bar.

No. 17.

Mark on bar, 1233.
Diameter, 1''.000; sectional area, .7854 square inch.
Gauged length, ''10.

Applied loads.		Elongation.	Remarks.
Total.	Per square inch.		
Pounds.	*Pounds.*	*Inch.*	
785	10,000	0.	
7,854	10,000	.0023	
15,708	20,000	.0058	
19,635	25,000	.0075	
23,562	30,000	.0095	
27,489	35,000	.0116	
29,854	38,000	.0130	
31,416	40,000	.0140	
32,201	41,000	.0145	
32,987	42,000	.0150	Elastic limit.
33,772	43,000	.0160	
34,558	44,000	.0170	
35,343	45,000	.0180	
36,128	46,000	.0195	
36,914	47,000	.0230	
37,699	48,000	.0280	
38,485	49,000	.0428	
39,270	50,000	.0792	
40,055	51,000	.0975	
40,841	52,000	.1020	
41,626	53,000	.1060	
42,412	54,000	.1152	
43,197	55,000	.1220	
43,982	56,000	.1292	
44,768	57,000	.1350	
45,553	58,000	.1455	
46,339	59,000	.1520	
47,124	60,000	.1610	Micrometer removed.
48,695	62,000	.17	
50,266	64,000	.19	
51,836	66,000	.21	
53,407	68,000	.23	
54,978	70,000	.25	
56,549	72,000	.27	
58,120	74,000	.31	Bar rested thirty minutes.
59,690	76,000	.33	
61,261	78,000	.37	
62,832	80,000	.41	
64,403	82,000	.45	
65,974	84,000	.50	
67,544	86,000	.54	
69,115	88,000	.62	
70,686	90,000	.70	
76,200	97,020	....	Ultimate strength.

Elongation after fracture, 1''.93 = 19.3 per cent.

Elongation of inch sections: ''.11, ''.17, .''15, ''.18, ''.20, ''.21 (''.37 fractured section), ''.24, ''.17, ''.13.

Diameter at fracture, ''.83.

Area, .5411 square inch.

Contraction of area, 31.1 per cent.

Fractured square across bar. Granular appearance, radiating from a dull spot ''.50 × ''.30, this spot being ''¼ eccentric.

Chemical analyses of bars furnished by Mr. George H. Billings.

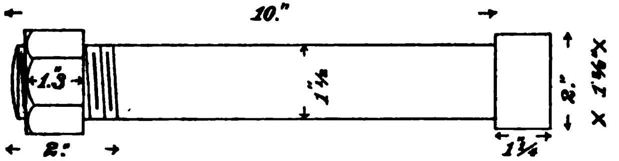
Test number.	Mark on bar.	Carbon.	Manganese.	Silicon.
16	13-1	0.86	0.53	0.095
17	1233	0.47	0.74	0.046

11.—TENSILE TESTS OF WROUGHT-IRON BOLTS.

[For W. R. King, Major of Engineers, U. S. A.]

The bolts were threaded with V threads. Seven 1″ sections laid off on the bodies of the bolts before testing. They were secured to the testing machine by their heads and nuts.

Style of specimens.



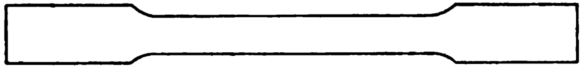
No. of test.	Threads per inch.	Body of bolt.		At root of thread.		Ultimate strength.			Mean comparative strength of bolts.	Description of fracture.	Elongation of 1″ sections.
		Diameter.	Sectional area.	Diameter.	Sectional area.	Total.	Per square inch.				
							On body.	At root of thread.			
		Inches.	*Sq. inches.*	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*			*Inch.*
7	6	1.49	1.74	1.18	1.09	67,400	38,740	61,830	100	Fractured at root of last thread; appearance fibrous, with granular streak.	.02, .02, .02, .02, .02, .02, .01
8	6	1.49	1.74	1.20	1.13	65,250	37,500	57,740		Fractured at root of last thread; appearance fibrous.	.02, .02, .02, .02, .02, .02, .02
9	12	1.50	1.77	1.31	1.35	80,600	45,540	59,700	116	Fractured at root of thread at face of nut; appearance fibrous, with granular streak.	.06, .05, .05, .05, .04, .04, .04
10	12	1.50	1.77	1.30	1.33	76,200	43,050	57,290		Fractured at root of thread at face of nut; appearance fibrous. Iron seamy.	.05, .04, .04, .04, .03, .04, .04

Surface cracks (crosswise) along body of bolt No. 8 were developed during the test.

12.—TENSILE TESTS OF WROUGHT-IRON PLATE AND BARS.

[For James G. Hill, Supervising Architect, Washington, D. C. Material for Government buildings at Kansas City, Mo.]

Form of specimens.



Eight 1″ sections laid off on specimens before testing.

No. of test.	Mark on specimen.	Dimensions.		Sectional area.	Elastic limit.		Ultimate strength.		Elongation in 8″.		Area at fracture.	Contraction of area.	Appearance of fracture.	Elongation of 1″ sections.
		Width.	Thickness.		Total.	Per square inch.	Total.	Per square inch.						
		Inches.	*Inch.*	*Sq. in.*	*Pounds*	*Pounds.*	*Pounds.*	*Pounds.*	*Inches.*	*Per ct.*	*in.*	*Per ct.*		*Inch.*
1	K 246 •	.994	.510	.507	18,450	36,390	28,040	55,310	1.57	19.6	.89 × .41 = .365	28.0	Fibrous lamellar..	.21, .19, .18, .16, .15, .18, .20, .20*
2	K 246 • •	.994	.493	.490	16,200	33,060	26,120	53,310	1.28	16.0	.90 × .41 = .369	24.7	... do	.16, .15, .16, .26*, .14, .15, .14, .12
3	K 247 •	1.325	.383	.507	17,800	35,110	26,280	51,830	.98	12.3	1.24 × .33 = .409	19.8	.. do	.11, .10, .11, .11, .11, .10, .13, .21*
4	K 247 • •	1.325	.383	.507	18,400	36,290	27,000	53,250	1.36	17.0	1.24 × .32 = .397	21.7	....do	.16, .17, .15, .16, .24*, .17, .16, .15
5	•	.808	diam.	.513	16,950	33,040	28,440	55,440	2.28	28.5	.62 diam. = .302	41.1	Fibrous..........	.21, .20, .25, .53*, .32, .27, .26, .24
6	• •	.802	diam.	.505	16,120	31,920	27,360	54,180	1.70	21.3	.59 diam. = .273	46.0	Fibrous surface seamy.	.07, .07, .12, .16, .48*, .31, .25, .24

* Indicates fractured section.

Specimens marked • and • • were turned down from 1″ × 1″ bars.

13.—ADHESION OF NAILS, SPIKES, AND SCREWS IN VARIOUS WOODS.

EXPERIMENTS ON THE RESISTANCE OF CUT NAILS, WIRE NAILS (STEEL), SPIKES, WOOD-SCREWS, LAG-SCREWS.

(The experiments were made in the following kinds of wood: White pine, yellow pine, chestnut, white oak, laurel.)

Experiments were made with single nails, spikes, and screws driven perpendicular and parallel to the grain of the wood; also with cleats held by two or four nails.

Cut nails and spikes were driven with the taper of their sides or points acting lengthwise the grain of the stick, unless otherwise mentioned in the details.

Trials were made with cut-nails barbed.

The wood employed was thoroughly seasoned dry stocks, excepting the stick of chestnut, which was unseasoned, and the blocks of pine and oak which were exposed to the tide-water after the nails had been driven.

The adhesive resistance of the different nails and screws is reduced to pounds per square inch of surface in the wood; computing the surface of the screws from the cylindrical surface at the top of the threads, multiplied by the length driven, deducting from this area the surface of the points of the screws which offered no resistance in the wood. The same allowance was made for the points in computing the surface of spikes.

Holes were bored the size of the screw at the root of the thread, or slightly smaller, for all wood-screws in hard woods, and for lag-screws in both hard and soft woods.

Few sticks were experimented upon, as it was considered desirable, so far as practicable, to obtain for comparative results the resistance of the different-sized nails and screws in the same stick. The cross-section dimensions of the common spikes were ″.50 × ″.50 and of the railroad spikes ″.59 × ″.59 by 6″ long.

Discussion of results.

The strength of timber is found to vary within wide limits, not only in different sticks of the same species, but in the same tree.

The results here presented will therefore be accepted as indicating as closely as practicable, yet in a general way, the comparative resistance of nails and screws in the several sticks experimented upon. There are certain features, however, apparently well developed by these tests which may be enumerated as follows:

The method adopted of reducing the adhesion to pounds per square inch of surface in the wood is reliable when comparing nails, spikes, and screws among themselves; the resistance being in direct proportion to the surfaces in contact.

The adhesion of nails and spikes depends upon the compression of the fibers of the wood; hence increasing this compression increases the adhesion up to the limit when the wood splits.

The compression of the wood at right angles to the direction of the grain appears more efficient than the endwise compression, particularly in the white and yellow pine; therefore, by driving the nail with the taper crosswise its adhesion is increased provided the stick does not split.

Wire nails of cylindrical form, and spikes of uniform section above their points, offer less resistance than tapering forms. It is probable that large spikes displace too much wood for maximum efficiency in adhesion.

Barbed nails in white pine show increased resistance, while in yellow pine and oak the resistance is much diminished; from which it is inferred that except in very soft wood, barbing is a disadvantage.

Water-soaked sticks give less resistance than dry wood.

In driving, side blows of the hammer obviously should be avoided.

The average adhesion of several nails drawn at the same time is less than the adhesion of nails drawn singly.

The resistance of screws per square inch of surface is largely in excess of the resistance of nails.

The adhesion of nails is principally dependent upon the friction between the surface of the nail and the wood; whereas the screw-threads enter the wood and depend for strength upon the shearing and transverse resistance of the fibers.

The disturbance of fibers when the screws are drawn takes place at a distance of one or more diameters on either side of the screw, depending upon the toughness of the wood.

[Nails driven in white pine wood, perpendicular to the grain. Drawn out parallel to their length.]

Dimensions of stick A, 8″×3″, by 72″.25 long.
Specific gravity, .4666.

Size of nails.	Length driven.	Surface of nail in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
	Inches.	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	
8 d.	1.5	.705	306	317	4	Same nail.
8 d.	1.5	.705	264			
8 d.	1.5	.705	346			
8 d.	1.5	.705	332			
8 d.	1.5	.705	338			
9 d.	1.75	.857	362	390	455	
9 d.	1.75	.857	504			
9 d.	1.75	.857	340			
9 d.	1.75	.857	356			
10 d. F	2.25	.967	422	407	421	
10 d. F	2.25	.967	340			
10 d. F	2.25	.967	486			
10 d. F	2.25	.967	380			
20 d.	2.50	1.55	920	74	477	
20 d.	2.50	1.55	710			
20 d.	2.50	1.55	770			
20 d.	2.50	1.55	560			

[Nails and spikes driven in the same stick of white-pine wood, perpendicular to the grain. Drawn out parallel to their length.]

Dimensions of stick B, 7″.94 × 7″.94 by 72″.25 long.
Specific gravity, .4717.

Size of nail.	Length driven.	Surface of nail in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
	Inches.	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	
50 d.	3.00	2.64	1,020	915	347	
50 d.	3.00	2.64	845			
50 d.	3.00	2.64	882			
50 d.	3.00	2.64	912			
50 d.	4.00	3.60	1,344	1,305	363	
50 d.	4.00	3.60	1,395			
50 d.	4.00	3.60	1,216			
50 d.	4.00	3.60	1,264			
60 d.	3.00	2.79	980	976	350	
60 d.	3.00	2.79	1,056			
60 d.	3.00	2.79	950			
60 d.	3.00	2.79	918			
60 d.	4.00	3.80	1,160	1,292	340	
60 d.	4.00	3.80	1,275			
60 d.	4.00	3.80	1,338			
60 d.	4.00	3.80	1,394			
60 d.	4.00	3.80	1,440	1,456	370	Corners of nails barbed.
60 d.	4.00	3.80	1,492			
60 d.	4.00	3.80	1,510			
60 d.	4.00	3.80	1,382			

[Nails driven oblique to line of pull 30 degrees.]

60 d.	4.00	3.80	820	918	242	Tears up the wood and bends the nail.
60 d.	4.00	3.80	878			
60 d.	4.00	3.80	1,056			

[Nails driven with taper crosswise the grain.]

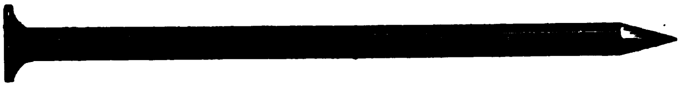
60 d.	4.00	3.80	1,744	1,749	460	
60 d.	4.00	3.80	1,836			
60 d.	4.00	3.80	1,848			
60 d.	4.00	3.80	1,570			

[Nails driven parallel to the grain.]

8 d.	1.50	.705	114	134	190	
8 d.	1.50	.705	168			
8 d.	1.50	.705	124			
8 d.	1.50	.705	199			
8 d.	1.50	.705	64			Driven within ⅛″ of a star check.
9 d.	1.75	.857	205	183	214	
9 d.	1.75	.857	188			
9 d.	1.75	.857	188			
9 d.	1.75	.857	150			
10 d. F	2.25	.967	222	243	251	
10 d. F	2.25	.967	168			
10 d. F	2.25	.967	318			
10 d. F	2.25	.967	262			
20 d.	2.50	1.55	336	369	238	
20 d.	2.50	1.55	426			
20 d.	2.50	1.55	355			
20 d.	2.50	1.55	360			

Size of nail.	Length driven.	Surface of nail in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
	Inches.	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	
50 d.	3.00	2.64	492	506	192	Split the wood.
50 d.	3.00	2.64	370			
50 d.	3.00	2.64	532			
50 d.	3.00	2.64	632			
50 d.	4.00	3.60	735	693	192	Do.
50 d.	4.00	3.60	808			
50 d.	4.00	3.60	690			
50 d.	4.00	3.60	533			
60 d.	3.00	2.79	622	458	164	Driven close by a star check.
60 d.	3.00	2.79	449			
60 d.	3.00	2.79	280			
60 d.	3.00	2.79	446			
60 d.	3.00	2.79	495			
60 d.	4.00	3.80	898	842	222	
60 d.	4.00	3.80	948			
60 d.	4.00	3.80	674			
60 d.	4.00	3.80	846			
60 d.	4.00	3.80	625	631	166	Barbed.
60 d.	4.00	3.80	640			
60 d.	4.00	3.80	610			
60 d.	4.00	3.80	648			

[Steel wire nails driven perpendicular to the grain. Stick B.]

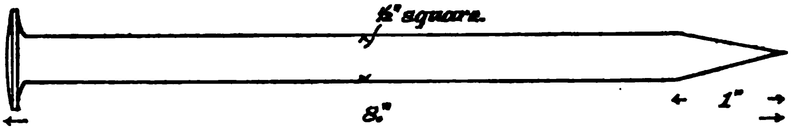


Length of nail.	Length driven.	Surface of nail in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
Inches.	*Inches.*	*Sq. inch.*	*Pounds.*	*Pounds.*	*Pounds.*	
3.00	2.00	.83	138	139	167	
3.00	2.00	.83	142			
3.00	2.00	.83	142			
3.00	2.00	.83	134			

[Driven parallel to grain.]

3.00	2.00	.83	112	105	126	
3.00	2.00	.83	78			
3.00	2.00	.83	110			
3.00	2.00	.83	118			

SPIKES.



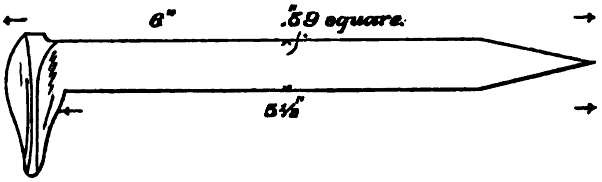
[Driven perpendicular to the grain. Stick B.]

Length of spike.	Length driven.	Surface of spike in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
Inches.	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	
8.00	4.00	6.00	1,060	1,456	224	
8.00	4.00	6.00	1,658			
8.00	4.00	6.00	1,685			
8.00	4.00	6.00	1,422			

[Driven parallel to the grain.]

8.00	4.00	6.50	430	453	70	
8.00	4.00	6.50	476			

[Railroad spikes driven perpendicular to the grain. Stick B.]



Length of spike.	Length driven.	Surface of spike in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
Inches.	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	
6	3.75	6.96	1,250	1,823	262	Not well driven; side blows given with hammer.
6	3.75	6.96	1,320			
6	3.75	6.96	1,980			
6	3.75	6.96	2,740			

STICK B.

[Nails and spikes driven into the wood perpendicular to the grain, when it was dry. The stick was then placed where exposed to tide-water and air, alternately, and allowed thus to be intermittingly wet for a period of thirteen days, and then tested.]

NAILS.

Size of nail.	Length driven.	Surface of nail in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
	Inches.	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*	
60 d.	4.00	3.80	746	747	197	
60 d.	4.00	3.80	715			
60 d.	4.00	3.80	745			
60 d.	4.00	3.80	790			

SPIKES.

8".00	4.00	6.50	1,550	1,499	231	
8.00	4.00	6.50	1,448			

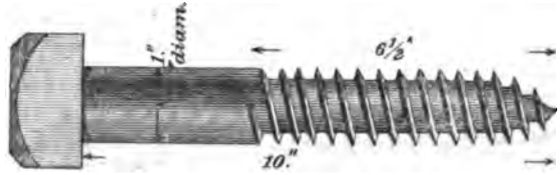
The above nails when withdrawn showed no signs of rust on the surface which was in the wood. The stick was apparently water-soaked as deep as the nails were driven.

STICK B.

[Yellow pine cleats 2⅜" thick, nailed with 60d. nails, driven 3" into the white pine perpendicular to the grain, the taper of the nails being crosswise the grain of the white pine.]

No. of nails.	How driven.	Surface of nails in wood.	Adhesive resistance.			Remarks.
			Total.	Average.		
				Total.	Per square inch of surface in wood.	
		Sq. inches.	*Pounds.*	*Pounds.*	*Pounds.*	
2	Perpendicularly	5.58	1,267	1,443	259	
2	....do	5.58	1,863			
2	....do	5.58	1,336			
2	....do	5.58	1,305			
4	....do	11.16	2,278	2,421	217	One of these nails split the wood.
4	....do	11.16	2,780			
4	....do	11.16	2,350			
4	....do	11.16	2,275			
2	Oblique 20°	5.58	2,240	1,773	318	
2	....do	5.58	1,210			
2	....do	5.58	1,745			
2	....do	5.58	1,897			
2	....do	5.58	894	894	160	Odd stick of white pine.
4	....do	11.16	2,590	2,860	256	Split the wood in drawing.
4	....do	11.16	2,485			
4	....do	11.16	2,874			
4	....do	11.16	3,490			

1" lag-screws driven perpendicular to the grain. Stick C.



4 Threads per inch.

	10.00 10.00	$\frac{11}{16}$ $\frac{11}{16}$	6.00 6.00	17.55 17.55	9,925 9,330	9,627	549

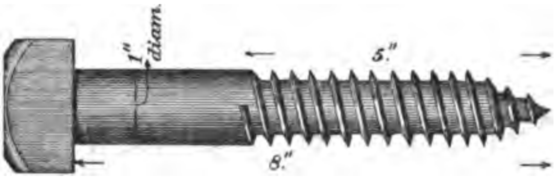
[Wood-screws driven in yellow pine wood, perpendicular to the grain. All screws have holes bored to receive them, the same depth as the length driven. The screws were greased with tallow before driving. The same stick of wood employed as with the nail tests. Stick D.]

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance.		
					Total.	Average.	
						Total.	Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*
12	1.50	$\frac{1}{8}$	.95	.56	785	904	1,614
12	1.50	$\frac{1}{8}$	.95	.56	852		
12	1.50	$\frac{1}{8}$	.95	.56	948		
12	1.50	$\frac{1}{8}$	.95	.56	1,030		
12	2.00	$\frac{1}{8}$	1.25	.79	1,316	1,322	1,673
12	2.00	$\frac{1}{8}$	1.25	.79	1,340		
12	2.00	$\frac{1}{8}$	1.25	.79	1,210		
12	2.00	$\frac{1}{8}$	1.25	.79	1,424		
14	2.00	$\frac{1}{8}$	1.25	.89	1,280	1,364	1,533
14	2.00	$\frac{1}{8}$	1.25	.89	1,285		
14	2.00	$\frac{1}{8}$	1.25	.89	1,316		
14	2.00	$\frac{1}{8}$	1.25	.89	1,576		
16	2.00	$\frac{5}{32}$	1.25	1.00	1,495	1,495	1,496
16	2.00	$\frac{5}{32}$	1.25	1.00	1,290		
16	2.00	$\frac{5}{32}$	1.25	1.00	1,530		
16	2.00	$\frac{5}{32}$	1.25	1.00	1,664		
18	2.00	$\frac{3}{16}$	1.25	1.11	1,668	1,635	1,473
18	2.00	$\frac{3}{16}$	1.25	1.11	1,448		
18	2.00	$\frac{3}{16}$	1.25	1.11	1,640		
18	2.00	$\frac{3}{16}$	1.25	1.11	1,786		
14	2.50	$\frac{1}{8}$	1.62	1.11	1,490	1,597	1,439
14	2.50	$\frac{1}{8}$	1.62	1.11	1,410		
14	2.50	$\frac{1}{8}$	1.62	1.11	1,624		
14	2.50	$\frac{1}{8}$	1.62	1.11	1,864		
18	2.50	$\frac{3}{16}$	1.62	1.28	1,695	1,733	1,354
18	2.50	$\frac{3}{16}$	1.62	1.28	1,650		
18	2.50	$\frac{3}{16}$	1.62	1.28	1,698		
18	2.50	$\frac{3}{16}$	1.62	1.28	1,890		
18	3.00	$\frac{3}{16}$	1.85	1.61	2,135	2,308	1,434
18	3.00	$\frac{3}{16}$	1.85	1.61	2,228		
18	3.00	$\frac{3}{16}$	1.85	1.61	2,390		
18	3.00	$\frac{3}{16}$	1.85	1.61	2,480		
18	3.50	$\frac{3}{16}$	2.10	1.75	2,388	2,488	1,422
18	3.50	$\frac{3}{16}$	2.10	1.75	2,090		
18	3.50	$\frac{3}{16}$	2.10	1.75	2,604		
18	3.50	$\frac{3}{16}$	2.10	1.75	2,870		

Screws driven parallel to the grain.

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance.		
					Total.	Average.	
						Total.	Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*
12	1.50	None	.95	.56	283	654	1,168
12	1.50	...do	.95	.56	635		
12	1.50	...do	.95	.56	868		
12	1.50	...do	.95	.56	830		
12	2.00	...do	1.25	.79	985	1,037	1,313
12	2.00	...do	1.25	.79	1,047		
12	2.00	...do	1.25	.79	1,070		
12	2.00	...do	1.25	.79	1,046		
14	2.00	...do	1.25	.89	907	929	1,044
14	2.00	...do	1.25	.89	1,035		
14	2.00	...do	1.25	.89	1,034		
14	2.00	...do	1.25	.89	740		
16	2.00	...do	1.25	1.00	1,458	1,235	1,235
16	2.00	...do	1.25	1.00	1,295		
16	2.00	...do	1.25	1.00	1,180		
16	2.00	...do	1.25	1.00	1,006		
18	2.00	...do	1.25	1.11	1,464	1,395	1,256
18	2.00	...do	1.25	1.11	1,390		
18	2.00	...do	1.25	1.11	1,144		
18	2.00	...do	1.25	1.11	1,582		
14	2.50	...do	1.62	1.11	1,340	1,510	1,360
14	2.50	...do	1.62	1.11	1,320		
14	2.50	...do	1.62	1.11	1,817		
14	2.50	...do	1.62	1.11	1,564		
18	3.50	...do	2.10	1.75	2,010	1,951	1,115
18	3.50	...do	2.10	1.75	1,805		
18	3.50	...do	2.10	1.75	2,190		
18	3.50	...do	2.10	1.75	1,798		

Lag-screws driven perpendicular to the grain. Stick D.



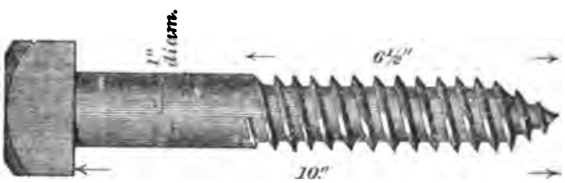
4 Threads per inch.

	8.00	11/16	5.00	....	13,350	12,777	983
(*)	8.00	11/16	5.00	....	10,740		
(†)	8.00	11/16	5.00	....	14,240		

* This screw split the grain 12" on either side at the surface of the stick.
† Split the grain 4" each side of the screw.

Dimensions of yellow-pine stick E, used in the following test:
Length, 10".9×10".9 by 48".10.
Specific gravity, .6428.
Rate of growth, 11 rings per inch.

Lag-screws driven perpendicular to the grain.



4 Threads per. inch.

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance.		
					Total.	Average.	
						Total.	Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*
	10.00	$\frac{11}{16}$	6.50	19.14	20,110	19,955	1,042
	10.00	$\frac{11}{16}$	6.50	19.14	19,800		
(*)	10.00	$\frac{11}{16}$	8.00	19.14	18,700	17,990	940
(*)	10.00	$\frac{11}{16}$	8.00	19.14	17,280		

* In computing the surface of screw in wood the length threaded (6".50) only was used.

[Wood screws driven in white oak plank, perpendicular to the grain. Drawn parallel to their length.]

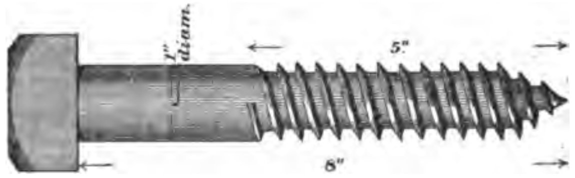
Dimensions of plank G: 3"×8" by 72".625 long.
Specific gravity, .8240.
Rate of growth, 6 rings per inch.

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance.		
					Total.	Average.	
						Total.	Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inch.*	*Pounds.*	*Pounds.*	*Pounds.*
12	1.50	$\frac{1}{8}$	.95	.56	1,590	1,653	2,952
12	1.50	$\frac{1}{8}$	.95	.56	1,618		
*12	1.50	$\frac{1}{8}$	.95	.56	1,750		
†12	2.00	$\frac{1}{8}$	1.25	.79	1,947	1,963	2,485
†12	2.00	$\frac{1}{8}$	1.25	.79	1,851		
†12	2.00	$\frac{1}{8}$	1.25	.79	1,960		
†12	2.00	$\frac{1}{8}$	1.25	.79	2,095		
14	2.00	$\frac{1}{8}$	1.25	.89	2,495	2,478	2,784
†14	2.00	$\frac{1}{8}$	1.25	.89	2,585		
14	2.00	$\frac{1}{8}$	1.25	.89	2,484		
14	2.00	$\frac{1}{8}$	1.25	.89	2,350		
16	2.00	$\frac{5}{32}$	1.25	1.00	2,440	2,439	2,439
16	2.00	$\frac{5}{32}$	1.25	1.00	2,685		
16	2.00	$\frac{5}{32}$	1.25	1.00	2,440		
16	2.00	$\frac{5}{32}$	1.25	1.00	2,190		
18	2.00	$\frac{3}{16}$	1.25	1.11	2,912	2,645	2,383
18	2.00	$\frac{3}{16}$	1.25	1.11	2,708		
18	2.00	$\frac{3}{16}$	1.25	1.11	2,665		
18	2.00	$\frac{3}{16}$	1.25	1.11	2,295		
†14	2.50	$\frac{5}{32}$	1.62	1.11	2,597	2,693	2,426
†14	2.50	$\frac{5}{32}$	1.62	1.11	2,685		
†14	2.50	$\frac{5}{32}$	1.62	1.11	2,700		
†14	2.50	$\frac{5}{32}$	1.62	1.11	2,790		

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance.		
					Total.	Average.	
						Total.	Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inches.*	*Pounds.*	*Pounds.*	*Pounds.*
18	2.50	$\frac{3}{16}$	1.62	1.28	3,822	3,605	2,816
†18	2.50	$\frac{3}{16}$	1.62	1.28	3,768		
*18	2.50	$\frac{3}{16}$	1.62	1.28	3,590		
18	2.50	$\frac{3}{16}$	1.62	1.28	3,290		
18	3.00	$\frac{3}{16}$	1.85	1.61	4,352	4,272	2,653
‡18	3.00	$\frac{3}{16}$	1.85	1.61	4,200		
†18	3.00	$\frac{3}{16}$	1.85	1.61	4,248		
‡18	3.00	$\frac{3}{16}$	1.85	1.61	4,290		
†18	3.50	$\frac{3}{16}$	2.10	1.75	4,400	4,273	2,442
†18	3.50	$\frac{3}{16}$	2.10	1.75	4,150		
†18	3.50	$\frac{3}{16}$	2.10	1.75	4,193		
†18	3.50	$\frac{3}{16}$	2.10	1.75	4,348		

* Driven near a knot. Pulled off screw-head.
† Fractured screw at root of thread.
‡ Pulled off screw-head.

[Lag-screws driven in white oak wood, perpendicular to the grain, drawn parallel to their length. The same stick of wood, F, employed as with the nail tests.]



4 Threads per inch.

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance.		
					Total.	Average.	
						Total.	Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inch.*	*Pounds.*	*Pounds.*	*Pounds.*
(*)	8	$\frac{11}{16}$	5	....	15,800	17,717	1,293
(†)	8	$\frac{11}{16}$	5	....	18,150		
(‡)	8	$\frac{11}{16}$	5	....	19,200		
(§)	8	$\frac{3}{4}$	5	....	14,380	14,380	1,050

* Split the grain 15" each side the screw.
† Split the grain 8" on one side of the screw and 10" on the opposite side.
‡ The fastenings of the stick yielded on one side, giving an oblique direction to the pull on the screw. After pulling, the screw was found bent about 5°. The grain of the wood was split 5" each side of the screw.
§ Split the grain 5" each side of the screw.

[Wood screws driven in California laurel wood, perpendicular to the grain, drawn parallel to their length. Same stick of wood employed in test No. 4381, Report of tests for 1883.]

Dimensions of stick: 4″ × 6″ × 40″ long.
Specific gravity, .7190.
Rate of growth, 14 rings per inch.

Number of screw.	Length of screw.	Diameter of hole.	Length driven.	Surface of screw in wood.	Adhesive resistance. Total.	Adhesive resistance. Average. Total.	Adhesive resistance. Average. Per square inch of surface in wood.
	Inches.	*Inch.*	*Inches.*	*Sq. inch.*	*Pounds.*	*Pounds.*	*Pounds.*
12	1.50	$\frac{1}{8}$	.95	.56	1,445	1,419	2,534
12	1.50	$\frac{1}{8}$	.95	.56	1,388		
12	1.50	$\frac{1}{8}$	.95	.56	1,395		
12	1.50	$\frac{1}{8}$	.95	.56	1,449		
*12	2.00	$\frac{1}{8}$	1.25	.79	2,008	2,046	2,587
*12	2.00	$\frac{1}{8}$	1.25	.79	2,085		
*12	2.00	$\frac{1}{8}$	1.25	.79	2,100		
*12	2.00	$\frac{1}{8}$	1.25	.79	1,990		
14	2.00	$\frac{1}{8}$	1.25	.89	2,134	2,120	2,382
14	2.00	$\frac{1}{8}$	1.25	.89	2,070		
14	2.00	$\frac{1}{8}$	1.25	.89	2,100		
14	2.00	$\frac{1}{8}$	1.25	.89	2,175		
16	2.00	$\frac{5}{32}$	1.25	1.00	2,236	2,317	2,317
16	2.00	$\frac{5}{32}$	1.25	1.00	2,238		
16	2.00	$\frac{5}{32}$	1.25	1.00	2,395		
16	2.00	$\frac{5}{32}$	1.25	1.00	2,400		
18	2.00	$\frac{3}{16}$	1.25	1.11	2,270	2,244	2,023
18	2.00	$\frac{3}{16}$	1.25	1.11	2,282		
18	2.00	$\frac{3}{16}$	1.25	1.11	2,228		
18	2.00	$\frac{3}{16}$	1.25	1.11	2,195		
†14	2.50	$\frac{5}{32}$	1.62	1.11	2,440	2,321	2,090
*14	2.50	$\frac{5}{32}$	1.62	1.11	2,425		
*14	2.50	$\frac{5}{32}$	1.62	1.11	2,390		
†14	2.50	$\frac{5}{32}$	1.62	1.11	2,030		
18	2.50	$\frac{3}{16}$	1.62	1.28	3,138	3,158	2,467
†18	2.50	$\frac{3}{16}$	1.62	1.28	2,960		
18	2.50	$\frac{3}{16}$	1.62	1.28	3,295		
18	2.50	$\frac{3}{16}$	1.62	1.28	3,240		
18	3.00	$\frac{3}{16}$	1.85	1.61	3,780	3,691	2,293
18	3.00	$\frac{3}{16}$	1.85	1.61	3,900		
18	3.00	$\frac{3}{16}$	1.85	1.61	3,884		
†18	3.00	$\frac{3}{16}$	1.85	1.61	3,200		
18	3.50	$\frac{3}{16}$	2.10	1.75	3,988	4,113	2,350
*18	3.50	$\frac{3}{16}$	2.10	1.75	4,108		
*18	3.50	$\frac{3}{16}$	2.10	1.75	4,100		
18	3.50	$\frac{3}{16}$	2.10	1.75	4,256		

* Fractured screw at root of thread.

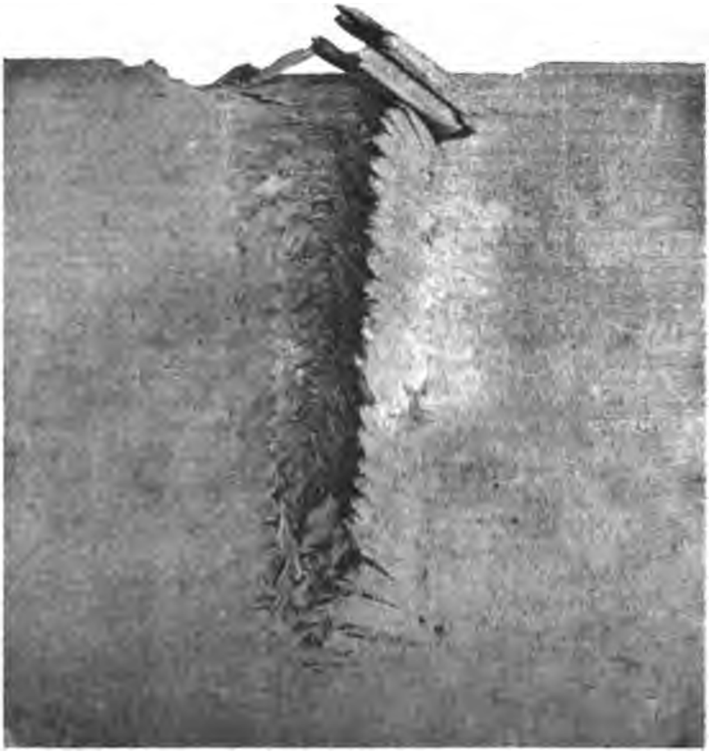
† Pulled off screw-head.

ADHESIVE RESISTANCE OF NAILS, SPIKES, AND SCREWS IN VARIOUS WOODS.

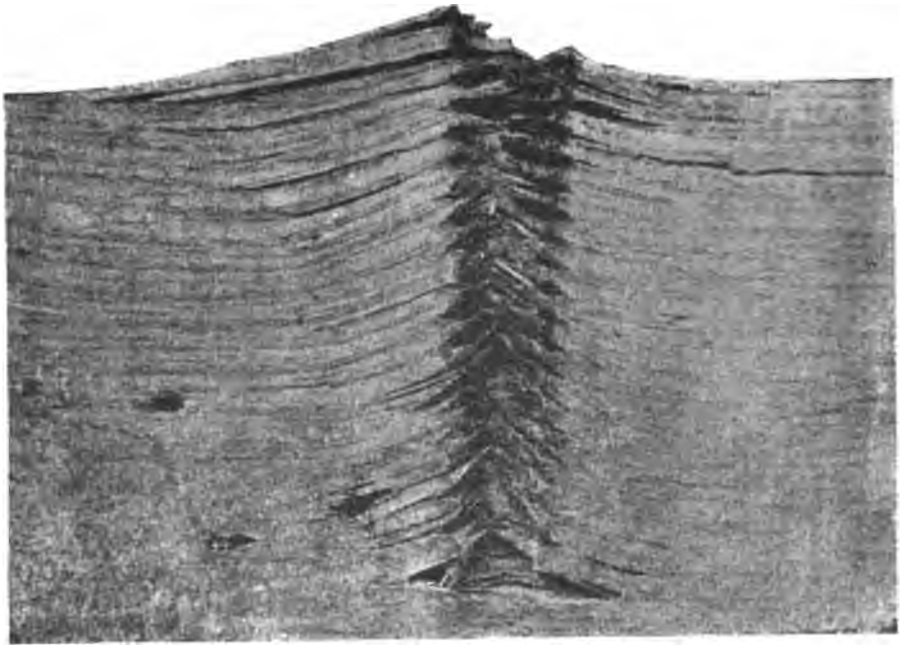
[General averages.]

Kind of wood.	Kind of nail, spike, or screw.	Average adhesive resistance per square inch of surface in wood.	
		Driven perpendicular to the grain.	Driven parallel to the grain.
		Pounds.	*Pounds.*
White pine, stick A	Cut nails	451	
White pine, stick B	do	350	208
Do	Cut nails with corners barbed	370	166
Do	Cut nails driven with taper crosswise the grain.	460	
Do	Steel wire nails	167	126
Do	Common spikes	224	70
Do	Railroad spikes	262	
Do	Wood screws	925	654
Do	Lag-screws ¾" diameter	970	
Do	Lag-screws ¾" diameter; 5 threads per inch.	880	
Do	Lag-screws ⅝" diameter; 6 threads per inch.	857	
White pine, stick C	Lag-screws 1" diameter; 4 threads per inch.	551	
Yellow pine, stick D	Cut nails	661	530
Do	Cut nails with corners barbed	473	397
Do	Cut nails driven with taper crosswise the grain.	768	
Do	Steel wire nails	318	252
Do	Common spikes	432	
Do	Wood screws	1,493	1,213
Do	Lag-screws 1" diameter; 4 threads per inch.	933	
Yellow pine, stick E	Common spikes	629	
Do	Lag-screws 1" diameter; 4 threads per inch.	991	
White oak, stick F	Cut nails	1,195	1,070
Do	Cut nails with corners barbed	846	766
Do	Cut nails driven with taper crosswise the grain.	1,158	
Do	Steel wire nails	940	802
Do	Common spikes	764	
Do	Lag-screws 1" diameter; 4 threads per inch.	1,171	
White oak, plank G	Wood screws	2,598	
Chestnut	Cut nails	683	
Do	Cut nails with corners barbed	618	
Do	Cut nails driven with taper crosswise the grain.	735	
Do	Common spikes	720	
California laurel	Cut nails	1,179	651
Do	Steel wire nails	911	548
Do	Wood screws	2,338	

PHOTOGRAPH, SHOWING SECTION THROUGH HOLE IN WHITE PINE STICK, AFTER DRAWING 1 INCH LAG SCREW.



PHOTOGRAPH, SHOWING SECTION THROUGH HOLE IN WHITE OAK STICK, AFTER DRAWING 1 INCH LAG SCREW.



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14.—HEMP AND MANILA CORDAGE.

[Specimens received from Capt. E. P. Lull, U. S. N.]

The rope was made at the Boston navy-yard, and had been kept in store at the Washington navy-yard a period of ten years, except the Russia hemp, which was from the lot of rope exhibited by Hoth & Co., of St. Petersburg, at the foreign exhibition held in Boston in 1883.

It was tested to ascertain whether it was now serviceable or had deteriorated during this period.

The standard breaking strength of these sizes (new rope) was furnished by Commander C. V. Gridley, U. S. N., as follows:

Kind of rope.	Circumference.	Breaking load.	Weight per fathom.
	Inches.	*Pounds.*	*Pounds.*
3-strand manila	3¼	5,600	2.18
Do	3½	6,500	2.46
Do	3¾	7,750	2.65
3-strand hemp	3¼	8,500	2.40
Do	3½	9,700	2.98
Do	3¾	10,900	3.59
4-strand hemp	3¼	7,800	1.78
Do	3½	8,950	2.76
Do	3¾	9,930	3.70
Bolt rope	3½	9,800	2.85

The rope was secured in the testing machine either with a hitch made by taking a round turn over a 4½″ pin held from turning and then making fast the end to a smaller pin, or by passing the ends over 3½″ thimbles and securing to the standing part by means of seizing. Pins passing through the thimbles secured them to the testing machine.

There was a disposition to draw the ends through the seizing, which was overcome by making a becket-knot in the ends and tucking a strand from another rope through the standing part between the seizing and the thimbles. Chalking the rope was found to diminish the tendency to slip in the seizing.

The method of securing by means of seizing developed greater strength than when the hitch was employed. In each case, however, the strength of the manila exceeded the standard breaking strength of new rope, and when seizing was employed the hemp exceeded the standard; but with the hitch the hemp showed less strength than the manila.

Ropes generally part in the fastenings, and the kind of hitch employed exerts a decided influence in their apparent strength. It does not seem practicable to employ a hitch that shall strain the strands as evenly as they are laid in the rope.

It is seen that the relative strength of manila and hemp rope is changed by different fastenings.

Manila rope possesses greater ability to stretch than the hemp, in consequence of which it more readily adapts itself to the uneven pull of the strands at the fastening.

The ropes gave the highest results which did not slip in the fastenings during the test.

Where slipping occurred the highest load was generally reached before the slipping began.

TABULATION OF THE TENSILE STRENGTH OF MANILA ROPE.

Number of test.	Navy-yard number.	Circumference of rope.	Number of strands.	Number of yarns in strand.	Kind of fastening.	Elongation under loads of—		Breaking load.	Average breaking load.	Remarks.
		Inches.				*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*	
57	31	3¼	3	24	Hitch	....	....	9,600	9,380	Parted one strand.
58	31	3¼	3	24	....do	....	....	8,950		
59	31	3¼	3	24	....do	....	....	9,600		
60	32	3¼	3	24	....do	....	....	7,500	7,890	Do.
61	32	3¼	3	24	....do	....	....	8,600		
62	32	3¼	3	24	....do	....	....	7,580		
63	64	3¼	3	24	....do	....	....	9,150	8,590	Do.
64	64	3¼	3	24	....do	....	....	8,250		
65	64	3¼	3	24	....do	....	....	8,380		
202	118	3¼	3	24	Seizing	8,000	16.7	9,350	9,450	Parted one strand at the seizing.
203	118	3¼	3	24	..do	8,000	16.2	9,950		
204	118	3¼	3	24	..do	8,000	15.8	9,050		
207	117	3¼	3	24	....do	8,000	15.7	10,400	10,660	Parted one strand near middle of standing part.
208	117	3¼	3	24	....do	8,000	16.5	10,820		Parted one strand at the seizing.
209	117	3¼	3	24	....do	8,000	16.8	10,750		Do.
210	115	3¼	3	24	....do	8,000	16.2	10,420	9,930	Do.
211	115	3¼	3	24	....do	8,000	16.2	9,980		
212	115	3¼	3	24	....do	8,000	18.1	9,400		
193	122	3¼	3	25	..do	8,000	15.4	10,100	10,020	Parted two strands at seizing.
194	122	3¼	3	25	....do	8,000	14.6	9,980		Do.
195	122	3¼	3	25	....do	8,000	16.1	9,980		Parted one strand at seizing.
187	93	3⅜	3	27	do	....	....	9,500	11,120	Parted one strand.
188	93	3⅜	3	27	..do	....	....	12,150		Parted two strands.
189	93	3⅜	3	27	...do	9,000	15.0	11,700		Parted one strand at seizing.
190	94	3⅜	3	27	...do	9,000	14.1	11,000	10,500	Do.
191	94	3⅜	3	27	...do	8,000	16.7	9,980		Parted two strands at seizing.
192	94	3⅜	3	27	...do	8,000	17.2	10,550		Parted one strand at seizing.
66	66	3⅜	3	28	Hitch	....	....	10,500	10,650	Parted one strand.
67	66	3⅜	3	28	...do	....	....	10,050		Do.
68	66	3⅜	3	28	...do	....	....	11,400		Parted two strands and part of third.
199	120	3½	3	31	Seizing	10,000	16.3	11,050	11,180	Parted one strand at seizing.
200	120	3½	3	31	....do	10,000	15.2	11,400		Parted one strand two feet from seizing.
201	120	3½	3	31	....do	10,000	15.4	11,100		Parted one strand midway length of standing part.
69	67	3½	3	32	Hitch	....	....	11,100	11,630	Parted one strand.
70	67	3½	3	32	....do	....	....	12,200		
71	67	3½	3	32	....do	....	....	11,600		

72	68	3¾	3	....	....do	....	....	11, 750	11, 070	Do.
73	68	3¾	3	....	.. do	....	....	10, 900		
74	68	3¾	3	....	....do	....	....	10, 550		
196	121	3¾	3	33	Seizing	8, 000	12. 2	10, 800	11, 500	Parted at knot.
197	121	3¾	3	33	... do	8, 000	13. 0	11, 800		Parted one strand at seizing.
198	121	3¾	3	33	... do	10, 000	15. 3	11, 900		Do.
205	119	3¾	3	34	....do	10, 000	17. 0	11, 850	10, 380	Parted one strand at seizing.
206	119	3¾	3	34	... do	9, 000	13. 9	9, 400		Do.
		2d test.	....	....	Spliced eye .	....	....	9, 900		Parted standing part two feet from spliced eye.
75	....	*3½	3	24	Hitch.......	....	....	9, 550	....	Parted one strand.
76	....	*3⅝	3	28	.... do.......	....	....	11, 800	....	Do.
One strand from *3½ inches								4, 550	....	
One strand from *3⅝ inches								4, 880	....	

* New rope.

TABULATION OF THE TENSILE STRENGTH OF HEMP ROPE.

Number of test.	Navy-yard number.	Circumference of rope.	Number of strands.	Number of yarns per strand.	Kind of fastening.	Elongation under loads of.		Breaking load.	Average breaking load.	Remarks.
		Inches.				*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*	
45	69	3¼	3	29	Hitch	....	....	7,400	7,380	Parted one strand.
46	69	3¼	3	29	do	....	....	7,950		Parted two strands.
47	69	3¼	3	29	do	....	....	6,800		Parted one strand.
238	105	3¼	3	29	Seizing	8,000	8.8	11,300	12,050	Parted three strands near middle of standing part.
239	105	3¼	3	29	do	8,000	10.9	11,750		Parted three strands 1 foot from seizing.
240	105	3¼	3	29	do	8,000	8.3	13,100		Parted three strands at middle of standing part.
235	136	3¼	3	48	do	8,000	10.1	11,700	12,330	Bolt-rope. Parted two strands at seizing.
236	136	3¼	3	48	do	8,000	9.4	12,400		Parted three strands near middle of standing part.
237	136	3¼	3	48	do	8,000	9.9	12,900		Parted one strand under the seizing.
222	88	3¼	4	22	do	7,000	8.9	10,050	10,430	Parted two strands under seizing.
223	88	3¼	4	22	do	8,000	9.0	11,400		Parted three strands 6 inches from seizing.
224	88	3¼	4	22	do	8,000	9.4	9,850		Parted two strands under seizing.
33	76	3¼	4	23	Hitch	....	....	7,500	6,600	Parted four strands.
34	76	3¼	4	23	do	....	....	6,000		Do.
35	76	3¼	4	23	do	....	....	6,300		Parted two strands.
232	87	3¼	4	23	Seizing	8,000	10.8	10,500	10,580	Parted two strands in standing part 2 feet from seizing.
233	87	3¼	4	23	do	8,000	10.6	10,950		Parted two strands in standing part 6 inches from seizing.
234	87	3¼	4	23	do	8,000	10.4	10,280		Parted three strands near middle of standing part.
48	71	3⅛	3	34	Hitch	....	....	6,850	8,030	Parted two strands.
49	71	3⅛	3	34	do	....	....	8,550		
50	71	3⅛	3	34	do	....	....	8,700		
54	72	3⅛	3	51	do	....	....	10,100	9,430	Bolt-rope. Parted two strands.
55	72	3⅛	3	51	do	....	....	9,300		Do.
56	72	3⅛	3	51	do	....	....	8,900		Parted one strand.
244	138	3⅛	3	51	Seizing	10,000	9.2	11,300	11,870	Parted one strand at seizing.
245	138	3⅛	3	51	do	10,000	10.0	12,300		Parted three strands in eye front of thimble.
246	138	3⅛	3	51	do	10,000	8.3	12,000		Parted .wo strands near seizing.
219	85	3⅛	4	24	do	8,000	9.2	12,480	11,510	Parted two strands at seizing.
220	85	3⅛	4	24	do	8,000	9.6	12,250		Do.
221	85	3⅛	4	24	do	8,000	8.1	10,800		Parted two strands under seizing.
225	89	3⅛	4	26	do	8,000	12.7	8,050	8,710	Do.
226	89	3⅛	4	26	do	8,000	13.0	8,880		Parted two strands midway standing part.
227	89	3⅛	4	26	do	8,000	12.8	9,200		Parted two strands at seizing.
39	78	3⅛	4	27	Hitch	....	....	8,000	7,220	Parted two strands.
40	78	3⅛	4	27	do	....	....	6,500		
41	78	3⅛	4	27	do	....	....	7,150		

36	77	3⅛	4	28	Hitch			8,800	8,580	*Parted two strands.
37	77	3⅛	4	28	....do			8,680		Do.
38	77	3⅛	4	28	.. do			8,280		Parted one strand.
51	70	3¼	3	41	....do			7,300	7,700	Parted two strands.
52	70	3¼	3	41	... do			7,550		Parted one strand.
53	70	3¼	3	41	... do			8,250		
241	104	3¼	3	41	Seizing	10,000	11.4	12,900	12,930	Parted one strand at seizing.
242	104	3¼	3	41	....do	10,000	10.7	12,600		Parted two strands at middle of standing part.
243	104	3¼	3	41	....do	10,000	11.2	13,280		Parted two strands near seizing.
213	83	3¼	4	33	....do	7,000	8.1	14,200	13,550	Parted three strands front of eye.
214	83	3¼	4	33	.. do	8,000	8.1	12,800		Parted one strand front of eye.
215	83	3¼	4	33	....do	8,000	8.3	13,550		Parted two strands front of eye.
216	84	3¼	4	33	....do	8,000	8.3	12,000	12,210	
217	84	3¼	4	33	....do	9,000	9.3	9,350		Parted two strands front of thimble.
	2d test.	....	....	....	Spliced eye	....	....	11,400		Parted one strand at the splice.
218	84	3¼	4	33	Seizing	8,000	8.9	12,100		Parted two strands between thimble and seizing.
42	79	3¼	4	35	Hitch			8,900	9,370	Parted two strands.
43	79	3¼	4	35	...do			8,700		Do.
44	79	3¼	4	35	....do			10,500		Parted three strands.
228	....	*4	3	50	Spliced eyes	10,000	14.4	10,050	....	Parted one strand at the splice.
77	....	†3¼	3	32	Hitch			8,350	....	Parted one strand.
78	....	†3⅛	3	36	... do			8,650	....	Parted two strands.
One strand from †3¼"								4,200	....	
One strand from †3⅛"								4,400	....	

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* Russia hemp.

† New rope.

HEMP AND MANILA CORDAGE.

No. 189. (Navy-yard No. 93.)

Manila rope.

3½″, 3 strands.
27 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.2	
2,000	6.7	
3,000	8.3	
4,000	10.0	
5,000	11.7	
6,000	12.5	
7,000	13.7	
8,000	14.2	
9,000	15.0	
11,700	....	Breaking load.

Parted 1 strand at seizing.

No. 190. (Navy-yard No. 94.)

Manila rope.

3½″, 3 strands.
27 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.1	
2,000	4.2	
3,000	6.7	
4,000	8.3	
5,000	10.4	
6,000	11.4	
7,000	12.5	
8,000	13.0	
9,000	14.1	
11,000	....	Breaking load.

Parted 1 strand at seizing.

No. 191. (Navy-yard No. 94.)

Manila rope.

3½″, 3 strands.
27 yarns per strand.
Strands laid one turn in 3⅛ inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.7	
2,000	7.3	
3,000	9.9	
4,000	12.5	
5,000	14.1	
6,000	14.6	
7,000	15.8	
8,000	16.7	
9,980	....	Breaking load.

Parted 2 strands at seizing.

No. 192. (Navy-yard No. 94.)

Manila rope.

2½″, 3 strands.
27 yarns per strand.
Strands laid one turn in 3⅓ inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	5.4	
2,000	8.1	
3,000	10.4	
4,000	12.3	
5,000	14.6	
6,000	15.4	
7,000	16.1	
8,000	17.2	
10,550	....	Breaking load.

Parted 1 strand at seizing.

No. 193. (Navy-yard No. 122.)

Manila rope.

3¼″, 3 strands.
25 yarns per strand.
Strands laid one turn in 3 inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.2	
2,000	6.8	
3,000	8.9	
4,000	10.6	
5,000	12.3	
6,000	13.5	
7,000	14.6	
8,000	15.4	
10,100	....	Breaking load.

Parted 2 strands at seizing.

No. 194. (Navy-yard No. 122.)

Manila rope.

3¼″, 3 strands.
25 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
unds.	*Per cent.*	
1,000	4.7	
2,000	7.1	
3,000	8.8	
4,000	10.4	
5,000	12.0	
6,000	13.5	
7,000	14.4	
8,000	14.6	
9,980	....	Breaking load.

Parted 2 strands at seizing.

No. 195. (Navy-yard No. 122.)

Manila rope.

3¼", 3 strands.
25 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.7	
2,000	7.3	
3,000	9.9	
4,009	11.7	
5,000	13.3	
6,000	14.8	
7,000	15.6	
8,000	16.1	
9,980	....	Breaking load.

Parted 1 strand at seizing.

No. 196. (Navy-yard No. 121.)

Manila rope.

3¾", 3 strands.
33 yarns per strand.
Strands laid one turn in 3½ inches.
Elongations measured in 4½ feet.

Applied loads.	Elongation	Remarks.
Pounds.	*Per cent.*	
1,000	3.0	
2,000	4.6	
3,000	6.0	
4,000	7.6	
5,000	9.1	
6,000	10.6	
7,000	11.3	
8,000	12.2	
10,800	....	Failed at the knot.

No. 197. (Navy-yard No. 121.)

Manila rope.

3¾", 3 strands.
33 yarns per strand.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.7	
2,000	5.5	
3,000	7.2	
4,000	8.5	
5,000	10.0	
6,000	11.3	
7,000	12.0	
8,000	13.0	
11,800	....	Breaking load.

Parted 1 strand at seizing.

No. 198. (Navy-yard No. 121.)

Manila rope.

3¾″, 3 strands.
33 yarns per strand.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.2	
2,000	6.3	
3,000	7.9	
4,000	9.7	
5,000	11.1	
6,000	11.6	
7,000	13.0	
8,000	13.9	
9,000	14.8	
10,000	15.3	
11,900	....	Breaking load.

Parted 1 strand at seizing.

No. 199. (Navy-yard No. 120.)

Manila rope.

3¾″, 3 strands.
31 yarns per strand.
Strands laid one turn in 3¼ inches.
Elongations measured in 6 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.9	
2,000	7.3	
3,000	9.2	
4,000	10.8	
5,000	11.9	
6,000	13.2	
7,000	14.2	
8,000	15.1	
9,000	15.8	
10,000	16.3	
11,050	....	Breaking load.

Parted 1 strand at seizing.

No. 200. (Navy-yard No. 120.)

Manila rope.

3¾″, 3 strands.
31 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.2	
2,000	6.2	
3,000	8.2	
4,000	9.6	
5,000	11.0	
6,000	12.1	
7,000	13.2	
8,000	14.0	
9,000	14.6	
10,000	15.2	
11,400	....	Breaking load.

Parted 1 strand in standing part, 2 feet from seizing.

No. 201. (Navy-yard No. 120.)

Manila rope.

3¾'', 3 strands.
31 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.3	
2,000	6.5	
3,000	8.2	
4,000	9.8	
5,000	10.8	
6,000	12.3	
7,000	12.9	
8,000	13.7	
9,000	14.8	
10,000	15.4	
11,100	....	Breaking load.

Parted 1 strand midway length of standing part.

No. 202. (Navy-yard No. 118.)

Manila rope.

3¼'', 3 strands.
24 yarns per strand.
Strands laid one turn in 3 inches.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	5.0	
2,000	7.9	
3,000	10.2	
4,000	12.7	
5,000	13.7	
6,000	15.0	
7,000	15.8	
8,000	16.7	
9,350	....	Breaking load.

Parted 1 strand at the seizing.

No. 203. (Navy-yard No. 118.)

Manila rope.

3¼'', 3 strands.
24 yarns per strand.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.4	
2,000	7.2	
3,000	9.4	
4,000	11.8	
5,000	13.1	
6,000	14.4	
7,000	15.6	
8,000	16.2	
9,950	....	Breaking load.

Parted 1 strand at the seizing.

No. 204. (Navy-yard, No. 118.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.6	
2,000	7.5	
3,000	9.6	
4,000	11.7	
5,000	13.3	
6,000	14.0	
7,000	15.0	
8,000	15.8	
9 050	....	Breaking load.

Parted 1 strand at the seizing.

No. 205. (Navy-yard No. 119.)

Manila rope.

3¼", 3 strands.
34 yarns per strand.
Strands laid one turn in 3¼ inches.
Elongations measured in 6 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	5.0	
2,000	7.3	
3,000	9.0	
4,000	10.5	
5,000	13.1	
6,000	13.7	
7,000	14.6	
8,000	15.6	
9,000	16.3	
10,000	17.0	
11,850	....	Breaking load.

Parted 1 strand at the seizing.

No. 206. (Navy-yard No. 119.)

Manila rope.

3¾", 3 strands.
34 yarns per strand.
Elongations measured in 7½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.7	
2,000	5.6	
3,000	7.1	
4,000	8.4	
5,000	9.9	
6,000	11.1	
7,000	11.9	
8,000	12.8	
9,000	13.9	
9,400	....	Breaking load.

Parted 1 strand at the seizing.
Fractured end prepared for 2d test with a spliced eye (tucked twice).
Breaking load 9,900 pounds.
Fractured standing part 2 feet from the spliced eye.

No. 207. (Navy-yard No. 117.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Strands laid one turn in 3¼ inches.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	6.0	
2,000	8.3	
3,000	10.6	
4,000	12.5	
5,000	13.4	
6,000	14.4	
7,000	15.0	
8,000	15.7	
10,400	....	Breaking load.

Parted 1 strand near middle of standing part.

No. 208. (Navy-yard No. 117.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.8	
2,000	7.4	
3,000	9.7	
4,000	12.2	
5,000	13.7	
6,000	14.6	
7,000	15.7	
8,000	16.5	
10,820	....	Breaking load.

Parted 1 strand at the seizing.

No. 209. (Navy-yard No. 117.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.8	
2,000	7.9	
3,000	10.6	
4,000	12.5	
5,000	13.9	
6,000	15.0	
7,000	16.2	
8,000	16.8	
10,750	....	Breaking load.

Parted 1 strand at the seizing.

No. 210. (Navy-yard No. 115.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Strands laid one turn in 3 inches.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	5.2	
2,000	7.8	
3,000	9.8	
4,000	12.1	
5,000	13.3	
6,000	14.8	
7,000	15.7	
8,000	16.2	
10,420	....	Breaking load.

Parted 1 strand at the seizing.

No. 211. (Navy-yard No. 115.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.6	
2,000	7.3	
3,000	9.3	
4,000	11.5	
5,000	13.2	
6,000	14.6	
7,000	15.7	
8,000	16.2	
9,980	....	Breaking load.

Parted 1 strand at the seizing.

No. 212. (Navy-yard No. 115.)

Manila rope.

3¼", 3 strands.
24 yarns per strand.
Elongations measured in 4½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	6.0	
2,000	8.8	
3,000	11.1	
4,000	13.0	
5,000	14.8	
6,000	15.9	
7,000	17.1	
8,000	18.1	
9,400	....	Breaking load.

Parted 1 strand at the seizing.

No. 213. (Navy-yard No. 83.)

Hemp rope.

3¾″, 4 strands.
33 yarns per strand.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.6	
2,000	3.9	
3,000	5.2	
4,000	6.0	
5,000	6.8	
6,000	7.3	
7,000	8.1	
14,200	....	Breaking load.

Parted 3 strands in front of the eye.

No. 214. (Navy-yard No. 83.)

Hemp rope.

3¾″, 4 strands.
33 yarns per strand.
Elongations measured in 3½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.6	
2,000	4.2	
3,000	5.0	
4,000	5.7	
5,000	6.2	
6,000	6.9	
7,000	7.4	
8,000	8.1	
12,800	....	Breaking load.

Parted 1 strand in front of the eye.

No. 215. (Navy-yard No. 83.)

Hemp rope.

3¾″, 4 strands.
33 yarns per strand.
Elongations measured in 3½ feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.3	
2,000	4.5	
3,000	5.3	
4,000	6.2	
5,000	6.9	
6,000	7.4	
7,000	7.7	
8,000	8.3	
13,550	....	Breaking load.

Parted 2 strands in front of the eye.

No. 216. (Navy-yard No. 84.)

Hemp rope.

3¾″, 4 strands.
33 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.9	
2,000	4.2	
3,000	5.2	
4,000	5.7	
5,000	6.4	
6,000	7.3	
7,000	7.8	
8,000	8.3	
12,000	....	Sustained this load, then slipped in the seizing. End knotted, the rope then parted under 11,000 pounds pull.

No. 217. (Navy-yard No. 84.)

Hemp rope.

3¾″, 4 strands.
33 yarns per strand.
Strands laid one turn in $3\frac{7}{16}$ inches.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.5	
2,000	3.5	
3,000	4.6	
4,000	5.4	
5,000	6.0	
6,000	6.7	
7,000	7.1	
8,000	7.5	
9,000	9.3	
9,350	....	Breaking load.

Parted 2 strands front of thimble. Rope cut on eye-plate of testing-machine in drawing up the fastening.

Fractured end prepared for second test with a spliced eye.

Breaking load, 11,400 pounds.

Fractured on strand at the splice.

No. 218. (Navy-yard No. 84.)

Hemp rope.

3¾″, 4 strands.
33 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.2	
3,000	5.4	
4,000	6.2	
5,000	7.1	
6,000	7.5	
7,000	8.3	
8,000	8.9	
12,100	....	Breaking load.

Parted 2 strands between thimble and seizing.

No. 219. (Navy-yard No. 85.)

Hemp rope.

3½″, 4 strands.
24 yarns per strand.
Strands laid one turn in 3.2 inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.7	
3,000	6.4	
4,000	5.7	
5,000	7.3	
6,000	7.8	
7,000	8.8	
8,000	9.2	
12,480	....	Breaking load.

Parted 2 strands at the seizing.
Rope did not slip in the seizing before fracture.

No. 220. (Navy-yard No. 85.)

Hemp rope.

3½″, 4 strands.
24 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.5	
2,000	5.2	
3,000	6.2	
4,000	7.1	
5,000	7.7	
6,000	8.3	
7,000	9.0	
8,000	9.6	
11,250	....	Breaking load.

Parted 2 strands at the seizing.

No. 221. (Navy-yard No. 85.)

Hemp rope.

3½″, 4 strands.
24 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.2	
3,000	5.0	
4,000	5.4	
5,000	6.2	
6,000	7.1	
7,000	7.5	
8,000	8.1	
10,800	....	Maximum load sustained, then the rope slipped in the fastenings.
9,800	....	Highest load sustained after drawing up the fastening.

Parted 2 strands under the seizing.

No. 222. (Navy-yard No. 88.)

Hemp rope.

3¼", 4 strands.
22 yarns per strand.
Strands laid one turn in 3 inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	5.0	
3,000	6.0	
4,000	6.8	
5,000	7.5	
6,000	8.1	
7,000	8.9	
8,000	....	
10,060	....	Maximum load sustained before the rope slipped in the fastenings.
8,000	....	Load which caused fracture after slipping in the fastenings.

Parted 2 strands under the seizing.

No. 223. (Navy-yard No. 88.)

Hemp rope.

3¼", 4 strands.
22 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.2	
2,000	4.6	
3,000	5.8	
4,000	6.7	
5,000	7.5	
6,000	7.9	
7,000	8.5	
8,000	9.0	
11,400	....	Breaking load.

Parted 3 strands 6 inches from the seizing.
Rope did not slip in the fastenings before fracture.

No. 224. (Navy-yard No. 88.)

Hemp rope.

3¼", 4 strands.
22 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.3	
2,000	4.7	
3,000	6.0	
4,000	6.4	
5,000	7.1	
6,000	8.5	
7,000	9.2	
8,000	9.4	
9,850	....	Maximum load sustained, then slipped in the fastenings, the load falling to 6,000 pounds while slipping was going on.
8,000	....	Highest load sustained, then parted two strands under the seizing.

(No. 225. (Navy-yard No. 89.)

Hemp rope.

3½″, 4 strands.
26 yarns per strand.
Strands laid one turn in 3 inches.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.5	
2,000	5.4	
3,000	7.1	
4,000	8.2	
5,000	9.8	
6,000	11.0	
7,000	12.1	
8,000	12.7	
8,050	....	Maximum load sustained, then slipped in the fastenings, load falling to 6,000 pounds while slipping was going on.
7,200	....	Highest load reached after the rope had drawn up the fastenings.

Parted 2 strands under the seizing.

No. 226. (Navy-yard No. 89.)

Hemp rope.

3½″, 4 strands.
26 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.6	
2,000	6.0	
3,000	7.8	
4,000	8.6	
5,000	9.9	
6,000	11.2	
7,000	12.2	
8,000	13.0	
8,880	....	Breaking load.

Parted 2 strands midway standing part of rope.
Rope did not slip in the fastenings.

No. 227. (Navy-yard No. 89.)

Hemp rope.

3½″, 4 strands.
26 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.6	
2,000	5.7	
3,000	7.8	
4,000	8.3	
5,000	9.4	
6,000	10.9	
7,000	12.0	
8,000	12.8	
9,200	....	Breaking load.

Parted 2 strands at the seizing.

No. 228.

Russia hemp rope.

4″, 3 strands.
50 yarns per strand.
Spliced eye at each end.
Strands laid one turn in 3⅓ inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	6.4	
2,000	8.3	
3,000	9.6	
4,000	10.6	
5,000	11.7	
6,000	12.3	
7,000	12.7	
8,000	13.3	
9,000	13.8	
10,000	14.4	
10,050	....	Breaking load.

Parted 1 strand at the splice.

No. 232. (Navy-yard No. 87.)

Hemp rope.

3¼″, 4 strands.
23 yarns per strand.
Strands laid one turn in 2¾ inches.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	8.9	
2,000	5.4	
3,000	6.7	
4,000	7.7	
5,000	8.5	
6,000	9.6	
7,000	10.2	
8.000	10.8	
10,500	....	Breaking load.

Parted 2 strands in standing part, 2 feet from seizing.

No. 233. (Navy-yard No. 87.)

Hemp rope.

3¼″, 4 strands.
23 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.4	
2,000	5.7	
3,000	6.8	
4,000	8.1	
5,000	8.8	
6,000	9.6	
7,000	10.2	
8,000	10.6	
10,950	....	Breaking load.

Parted 2 strands in standing part, 6 inches from seizing.

No. 234. (Navy yard No. 87.)

Hemp rope.

3¼″, 4 strands.
23 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.8	
3,000	6.0	
4,000	7.1	
5,000	7.9	
6,000	9.2	
7,000	9.8	
8,000	10.4	
10,280	....	Breaking load.

Parted 3 strands near middle of standing part.

No. 235. (Navy-yard No. 136.)

Hemp bolt rope.

3¼″, 3 strands.
48 yarns per strand.
Strands laid one turn in 3¼ inches.
Elongations measured in 3 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.5	
2,000	5.2	
3,000	6.6	
4,000	7.6	
5,000	8.3	
6,000	9.0	
7,000	9.4	
8,000	10.1	
11,700	....	Maximum load sustained, then slipped in the fastenings, the load falling to 6,000 pounds while the slipping was going on.
9,900	....	Highest load reached after the rope had drawn up in the fastenings.

Parted 2 strands at the seizing.

No. 236. (Navy-yard No. 136.)

Hemp bolt rope.

3¼″, 3 strands.
48 yarns per strand.
Elongations measured in 3 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.5	
2,000	4.9	
3,000	5.9	
4,000	6.9	
5,000	7.6	
6,000	8.3	
7,000	9.0	
8,000	9.4	
12,400	....	Breaking load.

Square break. Parted the 3 strands near middle of standing part. Rope did not slip in the fastenings.

No. 237. (Navy-yard No. 136.)

Hemp bolt rope.

3¼", 3 strands.
48 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.4	
2,000	5.7	
3,000	6.8	
4,000	7.5	
5,000	8.3	
6,000	8.8	
7,000	9.4	
8,000	9.9	
12,900	....	Breaking load.

Parted 1 strand under the seizing.
Rope did not slip in the fastenings.

No. 238. (Navy-yard No. 105.)

Hemp rope.

3¼", 3 strands.
29 yarns per strand.
Strands laid one turn in 3⅛ inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.4	
3,000	5.5	
4,000	6.5	
5,000	7.0	
6,000	7.8	
7,000	8.3	
8,000	8.8	
11,300	....	Breaking load.

Square break. Parted the 3 strands near middle of standing part.

No. 239. (Navy-yard No. 105.)

Hemp rope.

3¼", 3 strands.
29 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	4.2	
2,000	5.7	
3,000	6.8	
4,000	7.8	
5,000	9.1	
6,000	9.9	
7,000	10.4	
8,000	10.9	
11,750	....	Breaking load.

Square break. Parted all 3 strands in standing part, 1 foot from seizing.

No. 240. (Navy-yard No. 105.)

Hemp rope.

3¼", 3 strands.
29 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	2.1	
2,000	3.4	
3,000	4.7	
4,000	6.2	
5,000	6.8	
6,000	7.3	
7,000	7.8	
8,000	8.3	
13,100	....	Breaking load.

Square break. Parted all three strands at middle of the standing part.

No. 241. (Navy-yard No. 104.)

Hemp rope.

3¾", 3 strands.
41 yarns per strand.
Strands laid one turn in 3⅜ inches.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.4	
2,000	4.9	
3,000	6.5	
4,000	7.8	
5,000	8.6	
6,000	9.4	
7,000	10.2	
8,000	10.7	
9,000	10.9	
10,000	11.4	
12,900	....	Maximum load sustained, then slipped in the fastenings. Load fell to 6,000 pounds while the slipping was going on.
9,000	....	Highest load reached after slipping took place.

Parted 1 strand at the seizing.

No. 242. (Navy-yard No. 104.)

Hemp rope.

3¾", 3 strands.
41 yarns per strand.
Elongations measured in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.7	
3,000	6.0	
4,000	7.3	
5,000	8.3	
6,000	9.1	
7,000	9.6	
8,000	10.2	
9,000	10.4	
10,000	10.7	
12,600	....	Breaking load.

Parted 2 strands at the middle of the standing part.
Rope did not slip in the fastenings.

No. 243. (Navy-yard No. 104.)

Hemp rope.

3¾″, 3 strands.
41 yarns per strand.
Elongations taken in 4 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.6	
2,000	5.2	
3,000	6.5	
4,000	7.5	
5,000	8.3	
6,000	9.1	
7,000	9.6	
8,000	10.2	
9,000	10.7	
10,000	11.2	
13,280	....	Breaking load.

Parted 2 strands near the seizing.

No. 244. (Navy-yard No. 138.)

Hemp bolt rope.

3½″, 3 strands.
51 yarns per strand.
Strands laid one turn in 3¾ inches.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1,000	3.1	
2,000	4.1	
3,000	5.6	
4,000	6.2	
5,000	6.9	
6,000	7.5	
7,000	7.9	
8,000	8.8	
9,000	8.8	
10,000	9.2	
11,300	....	Breaking load.

Parted 1 strand at the seizing.

When the load reached 10,000 pounds, slipping in the fastening occurred, the load falling to 4,000 pounds. It recovered when the fastenings had drawn up, and reached the maximum load, 11,300 pounds, and fractured.

No. 245. (Navy-yard No. 138.)

Hemp bolt rope.

3½", 3 strands.
51 yarns per strand.
Elongations measured in 5 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1, 000	3. 9	
2, 000	5. 2	
3, 000	6. 2	
4, 000	7. 1	
5, 000	7. 7	
6, 000	8. 1	
7, 000	8. 8	
8, 000	9. 2	
9, 000	9. 6	
10, 000	10. 0	
12, 300	....	Breaking load.

Parted all 3 strands in eye, front of thimble. Slipping occurred when the load reached 10,000 pounds, the load falling to 4,000 pounds while the slipping was going on. Fracture occurred under the maximum load.

No. 246. (Navy-yard No. 138.)

Hemp bolt rope.

3½", 3 strands.
51 yarns per strand.
Elongations measured in 3 feet.

Applied loads.	Elongation.	Remarks.
Pounds.	*Per cent.*	
1, 000	3. 1	
2, 000	4. 2	
3, 000	5. 2	
4, 000	5. 9	
5, 000	6. 6	
6, 000	6. 9	
7, 000	7. 3	
8, 000	7. 6	
9, 000	8. 0	
10, 000	8. 3	
12, 000	....	Maximum load sustained when slipping in the fastenings began.

The load fell to 4,000 pounds while slipping was going on. It recovered once to 11,000 pounds and again slipped, falling off to 6,000 pounds, from which it recovered to 7,000 pounds, when fracture occurred.

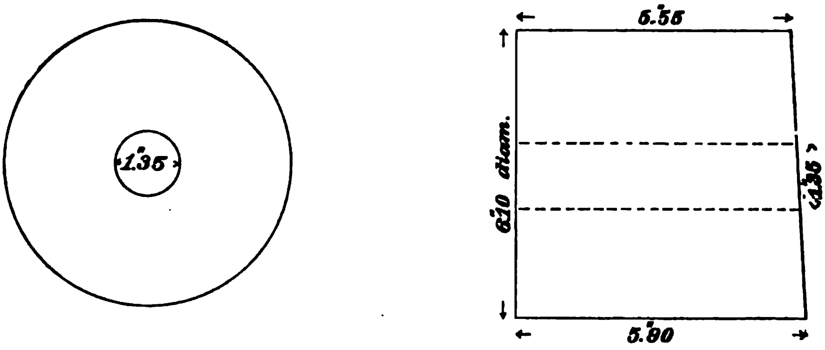
Parted 2 strands near the seizing.

15.—COMPRESSION OF (OLD) RUBBER SPRING.

[From gun carriage in course of alteration at Watertown Arsenal.]

No. 317.

Shape of spring before the test.

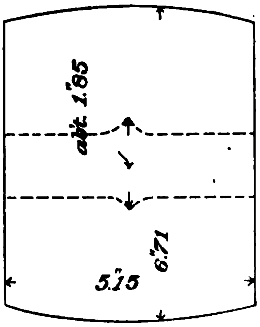


Weight, 10 pounds.
Sectional area, 27.8 square inches.

Applied loads.	Mean length.	Compression.	Compression sets.	Middle diameter.	Remarks.
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	
9	5.72	....	....	6.10	
1,000	5.32	.40	0.	6.38	Compression sets determined under load of 1,000 pounds.
2,000	4.84	.88	.10	6.72	
3,000	4.47	1.25	.18	7.06	
4,000	4.03	1.69	.29	7.48	
5,000	3.70	2.02	.33	7.79	
6,000	3.40	2.32	.37	8.12	
7,000	3.14	2.58	.42	8.44	
8,000	2.96	2.76	.39*	8.73	
9,000	2.80	2.92	.51	8.92	
10,000	2.68	3.04	.58	9.11	
11,000	2.60	3.12	.52*	9.24	
12,000	2.50	3.22	.60	9.42	
13,000	2.45	3.27	.67	9.55	
14,000	2.36	3.36	.73	9.68	
15,000	2.31	3.41	.74	9.77	
0	5.15	....	....	6.71	

* Before these sets were taken the load on the rubber was reduced to 500 pounds, then increased to 1,000 pounds, when the sets were measured.

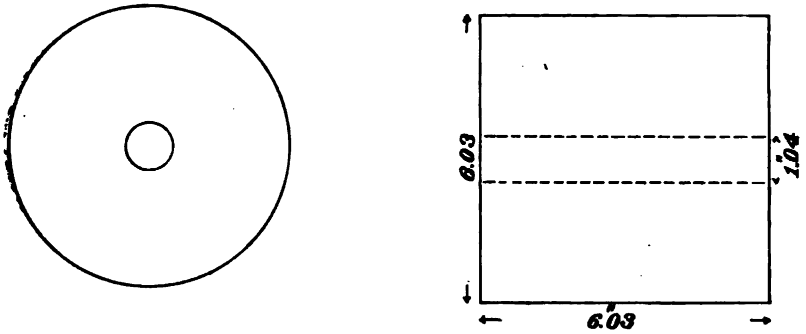
Shape after the test.



COMPRESSION OF NEW RUBBER GUN-CARRIAGE SPRINGS.

[Specimens stamped—"Manufactured by Boston Car Spring Co., Warrented."]

Shape of specimens.



Compression sets determined under initial load.
End diameters approximate when under load.

No. 318.

Length, 6″.03.
Diameter, 6″.03.
Diameter of core, 1″.04.
Sectional area, 27.71 square inches.
Weight, 11 pounds.

Applied loads.	Length.	Compression.	Compression sets.	Diameters.		Middle diameter under initial load.
				End.	Middle.	
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*
500	5.87	0.	0.	6.03	6.12	6.12
1,000	5.70	.17	.02	6.03	6.24	6.15
1,500	5.51	.36	.03	6.03	6.35	6.15
2,000	5.34	.53	.06	6.03	6.48	6.18
2,500	5.13	.74	.07	6.03	6.64	6.18
3,000	5.00	.87	.07	6.10	6.76	6.18
3,500	4.81	1.06	.09	6.15	6.87	6.18
4,000	4.65	1.22	.08	6.16	7.00	6.18
4,500	4.50	1.37	.08	6.18	7.15	6.19
5,000	4.35	1.52	.12	6.29	7.26	9.19
5,500	4.20	1.67	.12	6.38	7.41	6.19
6,060	4.06	1.81	.09	6.43	7.55	6.19
6,500	3.95	1.92	.13	6.50	7.66	6.21
7,000	3.83	2.04	.15	6.64	7.77	6.21
7,500	3.70	2.17	.15	6.70	7.91	6.22
8,000	3.62	2.25	.15	6.78	8.02	6.22
8,500	3.52	2.35	.16	6.89	8.13	6.22
9,000	3.43	2.44	.16	6.96	8.24	6.23
9,500	3.35	2.52	.17	7.06	8.34	6.24
10,000	3.25	2.62	.17	7.25	8.46	6.25

Spring removed from testing machine and measurements taken.
Length, 5″.90.
Middle diameter, 6″.08.
Measurements after spring had rested 20 hours:
Length, 6″.
Middle diameter, 6″.06.
Again placed in testing machine and test resumed.

Applied loads.	Length.	Compression.	Compression sets.	Diameters.		Middle diameter under initial load.
				End.	Middle.	
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*
500	5.84	.03	.03	6.01	6.15	6.15
6,000	4.00	1.87	....	6.55	7.63	....
10,000	3.29	2.58	....	7.25	8.40	....
10,500	3.21	2.66	....	7.35	8.48	....
11,000	3.16	2.71	....	7.39	8.54	....
11,500	3.11	2.76	....	7.46	8.60	....
12,000	3.06	2.81	.17	7.55	8.67	6.26
13,000	2.94	2.93	....	7.74	8.86	....
14,000	2.86	3.01	....	7.86	8.97	....
15,000	2.80	3.07	.22	7.94	9.04	6.30
16,000	2.71	3.16	....	8.10	9.20	....
17,000	2.65	3.22	....	8.20	9.28	....
18,000	2.61	3.26	....	8.27	9.35	....
19,000	2.56	3.31	....	8.36	9.42	....
20,000	2.53	3.34	.30	8.43	9.47	6.37

Spring removed from testing machine and measurements taken.
Length, 5″.86.
Middle diameter, 6″.24.
End diameter, 5″.90.
Ends concave, V. Sine ″.06 and ″.08.
Recovered in length to 5″.96 after 6 hours' rest.

No. 319. (Marked No. 2.)

Length, 6″.06.
Diameter, 5″.97.
Diameter of core, 1″.06.
Sectional area, 27.11 square inches.
Weight, 11 pounds.

Applied loads.	Length.	Compression.	Compression sets.	Diameters.		Middle diameter under initial load.
				End.	Middle.	
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*
500	5.90	0.	0.	5.97	6.07	6.07
1,000	5.75	.15	.02	5.97	6.16	6.07
1,500	5.59	.31	.02	5.97	6.27	6.08
2,000	5.41	.49	.06	5.98	6.38	6.10
2,500	5.25	.65	.05	6.02	6.48	6.10
3,000	5.05	.85	.09	6.05	6.62	6.12
3,500	4.90	1.00	.08	6.08	6.73	6.11
4,000	4.76	1.14	.10	6.14	6.88	6.12
4,500	4.61	1.29	.10	6.20	7.00	6.12
5,000	4.47	1.43	.11	6.25	7.11	6.12
5,500	4.33	1.57	.11	6.31	7.24	6.14
6,000	4.21	1.69	.12	6.37	7.32	6.15

Spring removed from testing machine and measurements taken.
Length, 5″.98.
Middle diameter, 6″.
End diameter, 5″.97.
Measurements after spring had rested 15 hours:
Length, 6″.02.
Middle diameter, 6″.
End diameter, 5″.96.
Spring now placed in testing machine and test resumed.

Applied loads.	Length.	Compression.	Compression sets.	Diameters.		Middle diameter under initial load.
				End.	Middle.	
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*
500	5. 90	0.	....	5. 97	6. 08	6. 08
6, 000	4. 27	1. 63	....	6. 35	7. 30	....
6, 500	4. 12	1. 78	. 08	6. 38	7. 41	6. 11
7, 000	4. 00	1. 90	. 09	6. 50	7. 55	6. 12
7, 500	3. 90	2. 00	. 10	6. 57	7. 62	6 14
8, 000	3. 82	2. 08	. 10	6. 65	7. 73	6. 12
8, 500	3. 72	2. 18	. 11	6. 75	7. 8:	6. 14
9, 000	3. 62	2. 28	. 14	6. 84	7. 93	6. 16
9, 500	3. 52	2. 38	. 14	6, 93	8. 03	6. 17
10, 000	3. 45	2. 45	. 16	7. 00	8. 11	6. 17

Spring removed from testing machine and measurements taken.
Length, 5″.92.
Middle diameter, 6″.09.
Measurements after spring had rested 1 hour:
Length, 5″.98.
Middle diameter, 6″.06.
End diameter, 5″.95.
Spring again placed in testing machine and test resumed.

Applied loads.	Length.	Compression.	Compression sets.	Diameters.		Middle diameter under initial load.
				End.	Middle.	
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*
500	5. 83	. 07	. 07	5. 97	6. 13	6. 13
6, 000	4. 09	1. 81	....	6. 41	7. 47	....
10, 000	3. 46	2. 44	....	7. 00	8. 12	....
10, 500	3. 38	2. 52	....	7. 09	8. 22	....
11, 000	3. 34	2. 56	....	7. 15	8. 27	....
11, 500	3. 27	2. 63	....	7. 21	8. 36	....
12, 000	3. 17	2. 73	. 22	7. 26	8. 40	6. 22
13, 000	3. 10	2. 80	.. ..	7. 46	8. 57	....
14, 000	3. 02	2. 88	....	7. 51	8. 67	....
15, 000	2. 90	3. 00	. 26	7. 66	8. 70	6. 27
16, 000	2. 84	3. 06	....	7. 84	8. 95	....
17, 000	2. 79	3. 11	.. ..	7. 90	9. 02	....
18, 000	2. 75	3. 15	....	7. 97	9. 06	....
19, 000	2. 70	3. 20	....	8. 05	9. 13	... .
20, 000	2. 68	3. 22	. 37	8. 11	9. 19	6. 36

Applied loads.	Length.	Compression.	
Pounds.	*Inches.*	*Inches.*	
1, 000	5. 43	. 47	← Time of loading, 3 minutes. →
2, 000	5. 10	. 80	
3, 000	4. 75	1. 15	
4, 000	4. 43	1. 47	
5, 000	4. 10	1. 80	
6, 000	3. 80	2. 10	
7, 000	3. 58	2. 32	
8, 000	3. 38	2. 52	
9, 000	3. 25	2. 65	
10, 000	3. 15	2. 75	
11, 000	3. 05	2. 85	
12, 000	2. 98	2. 82	
13, 000	2. 91	2. 99	
14, 000	2. 85	3. 05	
15, 000	2. 81	3. 09	
16, 000	2. 78	3. 12	
17, 000	2. 74	3. 16	
18, 000	2. 70	3. 20	
19, 000	2. 67	3. 23	
20, 000	2. 63	3. 27	

Spring removed from testing machine and measurements taken.
Length, 5″.81.
Middle diameter, 6″.25.
End diameter, 5″.87.
Ends concave V. Sine ″.08 and ″.10.
Recovered in length to 5″.93 after 4 hours' rest.

PRIVATE TESTS.

[From July 1, 1883, to June 30, 1884.]

Date.		Material.	For whom tested.	
			Name.	City and State.
1883.				
July	12	2 wrought-iron eye-bars	Passaic Rolling Mill Company.	Paterson, N. J.
	12	do	Saint Louis and Santa Fé Railway.	Saint Louis, Mo.
	14	1 wrought-iron column	Dominion Bridge Company	Toronto, P. O.
	16	2 wrought-iron columns	do	Do.
	17	1 wrought-iron column	do	Do.
	18	3 steel plates	E. D. Leavitt, jr	Cambridgeport, Mass.
	19	1 steel plate	do	Do.
	23	2 wrought-iron eye-bars	Passaic Rolling Mill Company.	Paterson, N. J.
	24	3 wrought-iron eye-bars	City of Lowell	Lowell, Mass.
	24	4 wrought-iron stirrups	do	Do.
	25	1 wrought-iron column	Passaic Rolling Mill Company.	Paterson, N. J.
	26	2 wrought iron columns	do	Do.
	27	1 steel eye-bar	George S. Morrison	New York, N. Y.
	28	2 steel eye-bars	do	Do.
	30	1 steel eye-bar	do	Do.
Sept.	1	do	do	Do.
	3	do	do	Do.
	25	do	do	Do.
	27	3 steel boiler-plates	Philadelphia Water Department.	Philadelphia, Pa.
	28	2 steel boiler-plates	do	Do.
	28	12 steel boiler-plates	Channing Whitaker	Lowell, Mass.
	29	8 steel boiler-plates	E. D. Leavitt, jr	Cambridgeport, Mass.
Oct.	1	11 steel boiler-plates	do	Do.
	1	1 wrought-iron boiler-plate	H. E. Penney	Minneapolis, Minn.
	1	2 wrought-iron plates	Boston, Hoosac Tunnel and Western Railway.	Saratoga Springs, N.Y.
	2	10 steel boiler-plates	E. D. Leavitt, jr	Cambridgeport, Mass.
	3	8 steel boiler-plates	do	Do.
	4	do	do	Do.
	5	11 steel boiler-plates	do	Do.
	6	9 steel boiler-plates	do	Do.
	8	3 steel boiler-plates	Park Brothers & Co	Boston, Mass.
	8	4 steel boiler-plates	Channing Whitaker	Lowell, Mass.
	9	10 steel boiler-plates	do	Do.
	12	1 wrought-iron eye-bar	Boston, Hoosac Tunnel and Western Railway.	Saratoga, N. Y.
	13	do	do	Do.
	15	do	Central Bridge Works	Buffalo, N. Y.
	16	do	do	Do.
	16	1 steel eye-bar	George S. Morison	New York, N. Y.
	31	25 steel boiler-plates	City of Boston	Boston, Mass.
Nov.	1	3 wrought-iron bars	Lloyd & Symes	Do.
	1	14 steel plates	City of Boston	Do.
	1	1 wrought-iron bar	Dodge, Haley & Co	Do.
	1	4 wrought-iron plates	A. H. Howland	Quincy, Mass.
	2	2 wrought-iron braces	R. Estabrook & Son	South Boston, Mass.
	3	3 brick piers	City of Philadelphia	Philadelphia, Pa.
	5	7 brick piers	do	Do.
	6	2 brick piers	do	Do.
Dec.	10	6 pieces sandstone	H. H. Dodge	Washington, D. C.
	11	4 pieces sandstone	do	Do.
	12	7 wrought-iron bars	Dodge, Haley & Co	Boston, Mass.
	12	1 wrought-iron plate	Lloyd & Symes	Do.
	12	8 pieces belting	Yale and Towne Manufacturing Company.	Stamford, Conn.
	12	3 wrought-iron bars	Concord Axle Company	Penacook, N. H.
	13	10 pieces wrought-iron chain.	Train, Dorr & Co	Boston, Mass.

Date.	Material.	For whom tested.	
		Name.	City and State.
1883.			
Dec. 14	4 pieces belting	Talcott & Budlong	Providence, R. I.
14	14 steel boiler-plates	City of Boston	Boston, Mass.
15	12 steel boiler-plates	do	Do.
17	1 cast-iron bar	Golding & Co	Do.
28	2 pieces sandstone	Norcross Brothers	Do.
1884.			
Jan. 2	2 steel plates	Pennsylvania Railroad Company.	Altoona, Pa.
3	1 steel plate	do	Do.
3	5 steel bars	do	Do.
4	7 steel bars	do	Do.
5	8 steel bars	do	Do.
7	1 steel plate	do	Do.
8	7 wrought-iron bars	Concord Axle Company	Penacook, N. H.
9	5 steel plates	City of Boston	Boston, Mass.
9	1 steel plate	Lloyd & Symes	Do.
19	2 composition blocks	Martin & Brown	Do.
19	6 cast-iron bars	G. W. & F. Smith Iron Company.	Do.
21	3 cast-iron bars	do	Do.
23	4 cast-iron bars	do	Do.
24	4 steel plates	Philadelphia Water Department.	Philadelphia, Pa.
28	6 white-metal plates	Metallic Brush Company	Boston, Mass.
Feb. 6	1 cast-steel bar	Golding & Co	Do.
	1 cast-iron bar	do	Do.
15	2 pieces composition wire	Samuel Norris	Bristol, R. I.
27	1 wrought-iron boiler-plate	Chicago, Milwaukee and Saint Paul Railroad Company.	Boston, Mass.
Mar. 11	4 pieces rubber belting	Hall Rubber Company	Do.
11	1 cast-steel eye-bar	Jos. W. Howard	Do.
13	2 breeching hooks	Kenneth Mackay	Do.
Apr. 3	4 wrought-iron plates	Grand Trunk Railway	Montreal, P. Q.
5	1 piece stone	H. N. F. Marshall	Northfield, Mass.
7	2 wrought-iron bars	Cleveland, Brown & Co	Cleveland, Ohio.
8	1 wrought-iron bar	do	Do.
10	2 wrought-iron bars	do	Do.
11	do	do	Do.
12	3 bars iron	Concord Axle Company	Penacook, N. H.
12	2 bars steel	do	Do.
17	2 steel plates	E. D. Leavitt, jr	Cambridgeport, Mass.
18	do	do	Do.
19	3 steel plates	do	Do.
May 3	do	do	Do.
5	4 steel plates	do	Do.
6	do	do	Do.
7	do	do	Do.
8	do	do	Do.
9	do	do	Do.
10	do	do	Do.
June 2	2 steel plates	do	Do.
5	do	do	Do.
6	do	do	Do.
7	4 steel plates	do	Do.
10	2 steel plates	do	Do.
11	do	do	Do.
18	1 piece stone	H. N. F. Marshall	Northfield, Mass.

ERRATA.

Page 7: Page "64" should read page "69".
Page 13: Length center to center of pins should read "15′–0″".
Page 16: "Gauged length along center line of channel A, 200″". (Omission.)
Page 53: For "6.28" square inches read "5″.28".
Page 100: For "92″" brick pier read "12″".
Page 252: Supply page number of cylinder XI–285.
Page 291: Successive permanent set "0″.000404" should read "0″.000044".
Page 357: Permanent set section A "0″.012287" should read "0″.012787".
Page 358: Successive elongation section B "0″.005280" should read "0″.000280".
Page 449: Resistance of 8*d*. nails driven 1″.5 for "4 lbs. per square inch" read "450 lbs. per square inch".
Page 449: Total resistance of 20*d*. nails for "74 pounds" read "740 pounds".
Page 452: Surface of spikes driven in stick B for "6.00 square inches" read "6.50 square inches".
Page 456: "Spikes driven in stick D, surface in wood 6.50 square inches". (Omission.)

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